PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-314366
(43)Date of publication of application : 25.10.2002

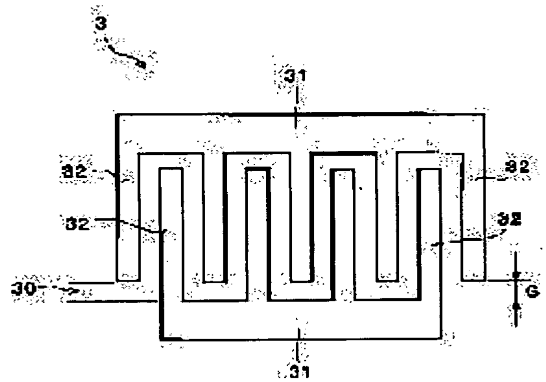
(51)Int.Cl. H03H 9/145
H03H 9/64

(21)Application number : 2001-110271
(22)Date of filing : 09.04.2001

(71)Applicant : MURATA MFG CO LTD
(72)Inventor : NOTO KENICHI

(54) SURFACE ACOUSTIC WAVE FILTER, SURFACE ACOUSTIC WAVE DEVICE AND COMMUNICATION EQUIPMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a high quality vertically coupled resonator surface acoustic wave filter having an excellent filter characteristic by improving flatness in the pass band.
SOLUTION: A turned Y-cut X propagation $LiTaO_3$ board is used as a piezoelectric board, and a gap length G in an IDT electrode 3 constituting a surface acoustic wave resonator is made as ≤0.3 times as long as the wavelength λof a surface acoustic wave ($0.3\lambda \geq G$). The gap length G is an interval between a pair of bus bars 31 constituting the IDT electrode 3 and a plurality of electric fingers 32,...: extending from the bus bars 31 in a facing direction.



LEGAL STATUS

[Date of request for examination]	07.11.2002
[Date of sending the examiner's decision of rejection]	
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]	
[Date of final disposal for application]	
[Patent number]	3498215
[Date of registration]	05.12.2003
[Number of appeal against examiner's decision of rejection]	
[Date of requesting appeal against examiner's decision of rejection]	
[Date of extinction of right]	

CLAIMS

[Claim(s)]
[Claim 1] It has two or more electrode fingers extended toward the opposite direction from the electrode terminal and each electrode terminal of the couple which counters mutually. The INTADIJITARU transducer electrode which forms the configuration where made these two or more electrode fingers cross, respectively, and each other were engaged In the surface acoustic wave filter of the vertical joint resonator mold which carries out contiguity arrangement along the propagation direction of a surface acoustic wave, and equips the both sides with two or more surface acoustic wave resonators which come to arrange the reflective structure further on a piezo-electric substrate It is the revolution Y cut X propagation $LiTaO_3$ as the above-mentioned piezo-electric substrate. While using a substrate The surface acoustic wave filter characterized by materializing the relation of 0.3 lambda>=G when spacing of the head of the above-mentioned electrode finger which one electrode terminal has, and the electrode terminal of another side which counters this is set to gap length G and wavelength of the above-mentioned surface acoustic wave is set to lambda.
[Claim 2] The above-mentioned electrode terminal is a surface acoustic wave filter according to claim 1 characterized by having two or more dummy electrode fingers formed so that the above-mentioned electrode finger extended from the other party's electrode terminal may be countered by projecting toward the above-mentioned opposite direction further.
[Claim 3] Surface acoustic wave equipment characterized by having a surface acoustic wave filter according to claim 1 or 2.
[Claim 4] The communication device characterized by using a surface acoustic wave filter according to claim 1 or 2 or surface acoustic wave equipment according to claim 3.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a communication device at a surface acoustic wave filter and surface acoustic wave equipment equipped with this, and a list, and is the revolution Y cut X propagation $LiTaO_3$ as a piezo-electric substrate especially. It is related with a surface acoustic wave filter, and the surface acoustic wave equipment and the communication device using this of the vertical joint resonator mold using a substrate.
[0002]
[Description of the Prior Art] A surface acoustic wave filter is a filter containing the surface acoustic element using the surface acoustic wave spread along a piezo-electric substrate front face, for example, is used for various applications prepared in a RF circuit, such as a surface acoustic wave filter, in mobile communications commercial scenes, such as a cellular phone.
[0003] Especially, since wavelength is short compared with an electromagnetic wave, the above-mentioned surface acoustic wave has the advantage of being easy to miniaturize surface acoustic wave equipment equipped with a surface acoustic wave filter itself. Therefore, in the field of communication devices, such as the above-mentioned cellular phone with which recent years more much more miniaturization and low back-ization are called for, the need of the above-mentioned surface acoustic wave filter or surface acoustic wave equipment is also very large.
[0004] Here, also in the above-mentioned surface acoustic wave filter, since especially the surface acoustic wave filter (it abbreviates to a vertical joint mold filter hereafter) of a vertical joint resonator mold can respond to low loss and a RF, its surface acoustic wave filter is in use.
[0005] As a concrete technique about such a vertical joint mold filter, the vertical joint dual mode surface acoustic wave filter currently indicated by JP,5-267990,A, for example is mentioned.
[0006] The vertical joint mold filter of the above-mentioned technique carries out contiguity arrangement of the three INTADIJITARU transducer electrodes (IDT electrode) along the propagation direction of a surface acoustic wave on a piezo-electric substrate, and has the configuration which arranges a reflector on the both sides further. And each IDT electrode limits spacing of the center to center of the electrode finger of the innermost part which counters mutually on the basis of the wavelength lambda of a surface acoustic wave. Consequently, it is possible to be able to realize the fractional bandwidth which reaches to 4%, even if it is a RF field near 1GHz, and to also make loss low.
[0007] By the way, although there are various things according to the application of this filter as a property required of a vertical joint mold filter including the technique of the above-mentioned official report, the filter for RKE(Remote Keyless Entry System) RF requires the property (narrow-band property) used as a narrow band especially, for example so that it can respond to necessary pass band width. In the former, in order to realize the above-mentioned narrow-band property to the vertical joint mold filter of this application, the Xtal substrate which has a zero temperature coefficient has been used as a piezo-electric substrate.
[0008] However, since the above-mentioned Xtal substrate has a low dielectric constant, an electromechanical coupling coefficient is also small and the impedance of the filter itself becomes high, a matching circuit is needed separately to a vertical joint mold filter. So, with the above-mentioned configuration, the inconvenient point in respect of [, such as complication of a configuration or an increment in components mark,] manufacture had arisen. And since loss became large, with the above-mentioned configuration, inconvenience had produced the vertical joint mold filter obtained also in respect of quality.

[0009] Then, in order to realize the above-mentioned narrow-band property recently, it is the revolution Y cut X propagation LiTaO3 especially as a piezo-electric substrate. The substrate is used more often. This revolution Y cut X propagation LiTaO3 As compared with what used the Xtal substrate, low impedance-ization of the vertical joint mold filter using a substrate is attained, and it is possible to control the above-mentioned inconvenience.
[0010]
[Problem(s) to be Solved by the Invention] However, it is the above-mentioned revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. If the vertical joint mold filter using a substrate tends to realize the above-mentioned narrow-band property, the trouble that surface smoothness worsens shortly will be produced.
[0011] As shown in drawing 10 , with the conventional vertical joint mold filter, the wave of a passband tapers off and, specifically, it has become a configuration (drawing Nakaya mark). Therefore, the ripple deflection used as the index of the surface smoothness in a passband gets worse, and the trouble that the width of face of a passband becomes narrow beyond the need is produced. In addition, the phenomenon in which the width of face of a passband becomes narrow beyond the need is made into a superfluous narrow-band-ized phenomenon.
[0012] This invention is made in view of the above-mentioned trouble, and the object is in offering a surface acoustic wave filter, and the surface acoustic wave equipment and the communication device using this of the quality vertical joint resonator mold which has the good filter shape which raised the surface smoothness in a passband further.
[0013]
[Means for Solving the Problem] this invention persons set in the surface acoustic wave filter of a vertical joint resonator mold, as a result of inquiring wholeheartedly, in order to cancel the above-mentioned trouble. As a piezo-electric substrate, it is the revolution Y cut X propagation LiTaO3. While using a substrate If spacing of the electrode finger which constitutes an IDT electrode, and the bus bar (electrode terminal) which counters this electrode finger is specified in the predetermined range based on the wavelength lambda of a surface acoustic wave The surface smoothness in a passband improves and it came to complete a header and this invention for a good filter shape being realized uniquely.
[0014] Namely, the surface acoustic wave filter concerning this invention In order to solve the above-mentioned technical problem, it has two or more electrode fingers extended toward the opposite direction from the electrode terminal and each electrode terminal of the couple which counters mutually. The INTADIJITARU transducer (IDT) electrode which forms the configuration where made these two or more electrode fingers cross, respectively, and each other were engaged In the surface acoustic wave filter of the vertical joint resonator mold which carries out contiguity arrangement along the propagation direction of a surface acoustic wave, and equips the both sides with two or more surface acoustic wave resonators which come to arrange the reflective structure further on a piezo-electric substrate It is the revolution Y cut X propagation LiTaO3 as the above-mentioned piezo-electric substrate. While using a substrate When spacing of the head of the above-mentioned electrode finger which one electrode terminal has, and the electrode terminal of another side which counters this is set to gap length G and wavelength of the above-mentioned surface acoustic wave is set to lambda, it is characterized by materializing the relation of 0.3 lambda>=G.
[0015] As a result of this invention persons' inquiring uniquely, it was considered to be the cause that the level of resonance mode decreased aggravation of the above-mentioned surface smoothness and generating of the superfluous narrow-band-ized phenomenon accompanying this under the effect of SSBW (Surface Skimming Bulk Wave) generated in the gap field between the head of the above-mentioned electrode finger and an electrode terminal (bus bar). It is known that this SSBW will be strongly emitted in the free surface. Therefore, if the non-exciting field which is equivalent to the free surface in an IDT electrode is made small, it will become possible to suppress generating of SSBW.
[0016] Then, according to the above-mentioned configuration, the wavelength lambda of a surface acoustic wave is shorter than 0.3 times, and gap length G which is spacing of the head of the above-mentioned electrode finger and an electrode terminal is carried out. Therefore, since the non-exciting field (gap field) equivalent to the above-mentioned free surface can be made small, it becomes possible to suppress generating of Above SSBW. Therefore, aggravation of the above-mentioned surface smoothness can be avoided and generating of a superfluous narrow-band-ized phenomenon can be prevented effectively. Consequently, the surface acoustic wave filter which has a high filter shape can be obtained.
[0017] In addition to the above-mentioned configuration, the surface acoustic wave filter concerning this invention is characterized by having two or more dummy electrode fingers formed so that the above-mentioned electrode finger

extended from the other party's electrode terminal when the above-mentioned electrode terminal projects toward the above-mentioned opposite direction further may be countered.
[0018] According to the above-mentioned configuration, it becomes possible by forming a dummy electrode finger to suppress generating of Above SSBW further so that the above-mentioned electrode finger may be countered. Therefore, aggravation of the above-mentioned surface smoothness can be avoided and generating of a superfluous narrow-band-ized phenomenon can be prevented effectively. Consequently, the surface acoustic wave filter which has a still higher filter shape can be obtained.
[0019] The surface acoustic wave equipment concerning this invention is characterized by having the surface acoustic wave filter of the above-mentioned configuration.
[0020] Moreover, the communication device concerning this invention is characterized by using the surface acoustic wave filter of the above-mentioned configuration, or the surface acoustic wave equipment of the above-mentioned configuration.
[0021] According to each above-mentioned configuration, since it has the surface acoustic wave filter of high quality, the function as surface acoustic wave equipment or a communication device can be raised further.
[0022]
[Embodiment of the Invention] [Gestalt 1 of operation] It will be as follows if the gestalt of operation of the 1st of this invention is explained based on drawing 1 thru/or drawing 7 . In addition, this invention is not limited to this.
[0023] The surface acoustic wave filter concerning this invention is the revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. On a substrate Have the resonator which has two or more INTADIJITARU transducer (IDT) electrodes and the reflective structure arranged so that this may be pinched. When wavelength of a surface acoustic wave is set to lambda, gap length G between the head of two or more electrode fingers which are the surface acoustic wave filters (vertical joint mold filter) of a vertical joint resonator mold, and the above-mentioned IDT electrode has, and the electrode terminal (bus bar) which counters it It sets up so that the relation of 0.3 lambda>=G may be materialized.
[0024] Moreover, the surface acoustic wave equipment concerning this invention is equipped with the surface acoustic wave filter of the above-mentioned configuration.
[0025] Specifically, for the vertical joint mold filter [in / as shown in drawing 2 / the gestalt of this operation] 1, the surface acoustic wave resonator 5 (it only considers as a resonator hereafter) which becomes two or more IDT electrode 3 -- from the reflector (reflector) 4-4 of a couple is LiTaO3. It has composition formed on [two] the substrate 2. In addition, a reflective end face may be used instead of a reflector. Namely, the reflective structure of a wide sense should just be used.
[0026] Contiguity arrangement of three IDT electrode 3a, 3b, and the 3c is carried out, and the above-mentioned resonator 5 has the composition that the reflector 4-4 of a couple is arranged to these ends. The direction where three IDT electrode 3a, 3b, and 3c are arranged is a direction which met in the propagation direction of the surface acoustic wave in the above-mentioned vertical joint mold filter 1. Moreover, since it is arranged so that above-mentioned IDT electrode 3a, 3b, and 3c may be pinched, the reflector 4-4 will be arranged along the propagation direction of a surface acoustic wave like the orientation of IDT electrode 3a, 3b, and 3c.
[0027] With the gestalt of this operation, among three above-mentioned IDT electrode 3a, 3b, and 3c, the end of IDT electrode 3a and 3c is grounded, and the signal terminal 7 is formed in IDT electrode 3b.
[0028] In the above-mentioned vertical joint mold filter 1, the direction where the resonator 5-5 is arranged is a direction (lengthwise direction) which intersects perpendicularly in the propagation direction of the above-mentioned surface acoustic wave. And cascade connection of between resonators 5-5 is done by the connection 6 between each IDT electrode 3a, 3b, and 3c. Therefore, the vertical joint mold filter 1 of the above-mentioned configuration has the so-called two-step composition. In addition, the joint capacity formed with the ctenidium-like electrode so that the above-mentioned connection 6 could take adjustment of interstage may have composition connected so that it may become parallel electrically with the above-mentioned IDT electrode 3, and it is not limited especially.
[0029] In addition, as a configuration of the above-mentioned vertical joint mold filter 1, it is not limited to the above-mentioned two-step configuration. For example, you may be what formed one resonator 5 and made the connection number of stages one step, i.e., the thing of a single stage configuration, and may be what prepared three or more resonator 5 --, i.e., the thing of three or more steps of multistage configurations. Moreover, between each resonator 5-5, the connection method of interstage is not limited to the above-mentioned approach, either, and may be changed into

other connection methods.
[0030] In drawing 2 , although each IDT electrode 3a, 3b, and 3c are illustrated typically, it has the composition of having two or more electrode finger (excitation electrode finger) 32 -- extended toward the bus bar (electrode terminal) 31-31 and each bus bar 31 of the couple which counters mutually as it is shown in drawing 1 , when a configuration is illustrated more concretely to the opposite direction of these IDT(s) electrode 3 --. Two or more above-mentioned electrode finger 32 -- crosses, respectively, and has become the configuration which was engaged mutually.
[0031] The logarithm of one pair, then the electrode finger 32-32 which constitutes the IDT electrode 3 is suitably set up according to the demand characteristics of the vertical joint mold filter 1 in the combination of the electrode finger 32-32 per piece extended, respectively from each bus bar 31-31 which counters. Similarly, the width of face (decussation width of face) which each electrode finger 32 extended, respectively intersects is suitably set up according to demand characteristics from the bus bar 31-31 which counters.
[0032] Furthermore, by this invention, as shown in drawing 1 , when spacing of the head of the above-mentioned electrode finger 32 and the bus bar 31 which counters this is set to gap length G and this gap length G sets wavelength of a surface acoustic wave to lambda, it is specified that the relation of 0.3 lambda>=G is materialized.
[0033] It is the above-mentioned revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. With the vertical joint mold filter using a substrate, if it is going to realize a narrow-band property, the superfluous narrow-band-ized phenomenon which surface smoothness worsened, therefore was mentioned above will arise. This superfluous narrow-band-ized phenomenon is a gap field between the head of the above-mentioned electrode finger, and a bus bar, and is considered for SSBW (Surface Skimming Bulk Wave) to occur. That is, SSBW is the effect generated in the above-mentioned gap field, and it is for the level of resonance mode to decline.
[0034] It is known that Above SSBW will be strongly emitted in the free surface. Then, in an IDT electrode, it is making small the non-exciting field equivalent to the above-mentioned free surface, and it becomes possible to suppress generating of Above SSBW.
[0035] Here, as shown in drawing 1 , the gap field 30 between the head of the electrode finger 32 in the IDT electrode 3 and the bus bar 31 which counters it is excitation with the free surface which has not contributed. So, if the above-mentioned gap length G is shortened, since the gap field 30 will become narrow, a non-exciting field can be made small. Consequently, the surface smoothness in a passband can be improved and it becomes possible to prevent a superfluous narrow-band-ized phenomenon.
[0036] When the correlation with the above-mentioned gap length G, the deflection in a band (ripple deflection), and the width of face (bandwidth) of a passband was acquired, wavelength of a surface acoustic wave was set to lambda and the above-mentioned gap length G was actually specified below to 0.3lambda so that clearly from the example mentioned later, it was found out that the deflection in a band and bandwidth are improved. The above-mentioned ripple deflection is the index of surface smoothness, and it becomes good [surface smoothness], so that this value is small. In this invention, when it prescribed that gap length G became 0.3 lambda>=G, it turned out that ripple deflection is improved and bandwidth also becomes large.
[0037] In addition, although, as for gap length G, only 0.3lambda is specified as an upper limit and the minimum is not specified, the above-mentioned gap length G is that which points out spacing of the head of the electrode finger 32, and a bus bar 31, and always exceeds 0 until it gets tired (G> 0), and this is because it is not necessary to limit a minimum.
[0038] That is, in this invention, the lower limit of gap length G will be equivalent to the threshold value on the process at the time of forming the above-mentioned IDT electrode 3 to the upper limit of gap length G being 0.3lambda. For example, as an approach of forming the IDT electrode 3, although the wet etching method can generally be used, it is also possible to use the dry etching method. At this time, the threshold value of gap length G obtained by the dry etching method becomes smaller than the threshold value of gap length G obtained by the wet etching method. Therefore, the minimum of gap length G serves as threshold value of the process which forms the IDT electrode 3.
[0039] In this invention, further, as shown in drawing 3 , the IDT electrode 3 has projected toward the above-mentioned opposite direction, and may have two or more dummy electrode finger 33 -- formed so that the above-mentioned electrode finger 32 extended from the other party's bus bar 31 may be countered. That is, the dummy electrode 33 will be formed so that it may project from a bus bar 31 to the gap field 30 which is a non-exciting field.
[0040] Thus, if the dummy electrode finger 33 which counters the above-mentioned electrode finger 32 is formed, it is possible to be able to avoid aggravation of the above-mentioned surface smoothness much more certainly, and to prevent generating of a superfluous narrow-band-ized phenomenon more effectively so that clearly from the example

mentioned later.
[0041] In addition, gap length G in case there is a dummy electrode finger 33 shall point out spacing from the head of the electrode finger 32 to the head of the dummy electrode finger 33 which counters it, as shown in drawing 3 . So, the die length of the dummy electrode finger 33 is a design matter chosen suitably, and is not especially limited by the size of above-mentioned gap length G and the IDT electrode 3 etc.
[0042] At this invention, it is the above-mentioned revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. A substrate 2 is used. This revolution Y cut X propagation LiTaO3 As a substrate 2, it is not especially specifically limited. At the example mentioned later, it is the revolution Y cut X propagation LiTaO3. Although the thing of 36-degree revolution Y cut X propagation is used, even if cut angles other than this are used for the cut angle of a substrate 2, since the difference in physical properties does not participate in radiation of SSBW, it can acquire the same effectiveness.
[0043] [Example] A convention of the above-mentioned gap length G in the gestalt of this operation is more concretely explained based on the following examples. In addition, this example is an example for specifying the above-mentioned gap length G, and this invention is not limited to this example.
[0044] The vertical joint mold filter 1 (refer to drawing 2) of the two-step configuration mentioned above is mentioned as an example, and this example explains it. The fundamental configuration of the vertical joint mold filter 1 used by this example is as follows.
[0045] That is, center frequency used as the center of the passband in the vertical joint mold filter 1 was first set to 298MHz. Moreover, as a piezo-electric substrate, it is the 36-degree revolution Y cut X propagation LiTaO3. The substrate 2 was used. Electrode layer thickness was set to 400nm, using an aluminum-Cu alloy as an electrode material. As for each concrete configuration of the above-mentioned reflector 4, the number set wavelength to 13.82 micrometers by 41. Moreover, the logarithm of the electrode finger 32-32 in three IDT electrode 3a, 3b, and 3c shown in drawing 2 formed the concrete configuration of the above-mentioned IDT electrode 3 so that it might become 17 pairs, 22 pairs, and 17 pairs, respectively.
[0046] next, with the vertical joint mold filter (this invention mold filter) concerning this invention used by this example, when wavelength of a surface acoustic wave is set to lambda, it becomes below 0.3lambda about gap length G (0.3 lambda>=G) -- it has set up small like. Furthermore, in this example, the conventional vertical joint mold filter (conventional-type filter) which does not set up gap length G small is also used as usual for the comparison. Although the fundamental configuration is the same as this invention mold filter as this conventional-type filter, gap length G is set as 0.46lambda (G=0.46lambda).
[0047] The transmission characteristic was compared about each of the above-mentioned this invention mold filter and a conventional-type filter. The result is shown in drawing 4 and drawing 5 . In addition, with this invention mold filter which measured the transmission characteristic of drawing 4 and drawing 5 , the gap length G is set as 0.2lambda (G=0.2lambda). Moreover, the dotted line of this invention mold filter shows the transmission characteristic of a conventional-type filter, and a continuous line shows drawing 4 and drawing 5 by **-**, respectively. Furthermore, the axis of ordinate in drawing shows an insertion loss, and an axis of abscissa shows a frequency.
[0048] Drawing 4 measures the transmission characteristic of each above-mentioned filter simply. With this invention mold filter, it turns out that the tapering inclination of the transmission characteristic in a band is canceled, and surface smoothness can be improved as compared with a conventional-type filter, without changing any properties other than a passband so that clearly from drawing 4 .
[0049] On the other hand, in each above-mentioned filter, in order to clarify the location and level of resonance mode, drawing 5 measures the wave of a transmission characteristic, after removing adjustment with an external circuit intentionally. If the level of resonance mode is seen so that clearly from the result of drawing 5 , compared with a conventional-type filter, the peak level will rise with this invention mold filter. Therefore, it turns out that making it small has contributed gap length G on a flat disposition rather than the conventional configuration.
[0050] Next, the result evaluated quantitatively about the relation between the above-mentioned gap length G and the surface smoothness in a passband is shown below.
[0051] First, in the vertical joint mold filter of the above-mentioned basic configuration, when changing gap length G, it measured about change of the ripple deflection (deflection in a band) to gap length G it is changeless against the index of the above-mentioned surface smoothness. The result is shown in drawing 6 . In addition, in drawing 6 , it is a vertical joint mold filter in case the dummy electrode finger 33 does not have a square black dot (configuration of

drawing 1), and is a vertical joint mold filter in case the dummy electrode finger 33 has the black dot of a rhombus (configuration of drawing 3). Moreover, an axis of ordinate shows the deflection in a band (unit dB), and an axis of abscissa shows gap length G (lambda criteria). Furthermore, the die length of the dummy electrode finger 33 is about 2 lambda in this example.
[0052] If gap length G has become below 0.3lambda so that clearly from the result of drawing 6 , it turns out that the value of ripple deflection is sufficiently small. It is very clear by filling 0.3 lambda>=G with a vertical joint mold filter in case there is a dummy electrode especially that ripple deflection is fully falling.
[0053] Next, in the vertical joint mold filter of the above-mentioned basic configuration, when changing gap length G, it measured about change of the width of face (bandwidth) of the passband to gap length G. The result is shown in drawing 7 . In addition, drawing 7 is also a vertical joint mold filter in case the dummy electrode finger 33 does not have a square black dot (configuration of drawing 1), and it is a vertical joint mold filter in case the dummy electrode finger 33 has the black dot of a rhombus (configuration of drawing 3). Moreover, an axis of ordinate shows bandwidth (unit MHz), and an axis of abscissa shows gap length G (lambda criteria).
[0054] If gap length G has become below 0.3lambda so that clearly from the result of drawing 7 , sufficiently good bandwidth can be obtained. On the other hand, it turns out that bandwidth will decrease rapidly if gap length G exceeds 0.3lambda, and a superfluous narrow-band-ized phenomenon arises. If 0.3 lambda>=G is not filled, it becomes impossible therefore, to obtain sufficient filter shape as a vertical joint mold filter.
[0055] Furthermore, if the value of ripple deflection is large, surface smoothness will worsen and a superfluous narrow-band-ized phenomenon will arise, so that clearly from the comparison of drawing 6 and drawing 7 , but if the above-mentioned gap length G is set below to 0.3lambda, ripple deflection will be improved, the width of face of a passband will fully be secured, and it will become possible to prevent generating of a superfluous narrow-band-ized phenomenon.
[0056] Thus, at this invention, it is the revolution Y cut X propagation LiTaO3. On a substrate, two or more IDT electrodes have been arranged at the single tier, and gap length G between the heads of an electrode finger and bus bars (electrode terminal) in an IDT electrode is set below to 0.3lambda in the surface acoustic wave filter of the vertical joint resonator mold which has arranged the reflective structures, such as a reflector, so that this may be pinched further. Therefore, the surface smoothness in a passband can be raised and generating of a superfluous narrow-band-ized phenomenon can be prevented certainly.
[0057] [Gestalt 2 of operation] It will be as follows if the gestalt of operation of the 2nd of this invention is explained based on drawing 8 and drawing 9 . In addition, this invention is not limited to this. Moreover, the same number is appended to the member of explanation used with the gestalt 1 of said operation, and the member which has the same function for convenience, and the explanation is omitted.
[0058] The gestalt of this operation explains more concretely about the example applied to the communication device the vertical joint mold filter in the gestalt 1 of said operation, or surface acoustic wave equipment equipped with this.
[0059] As shown in drawing 8 , the communication device 100 in the gestalt of this operation Specifically as a receiver side (Rx side) which receives An antenna 101, the antenna common section / RFTop filter 102, amplifier 103, Rx interstage filter 104, a mixer 105, the 1stIF filter 106, a mixer 107, the 2ndIF filter 108, the 1st+2nd local synthesizer 111, TCXO (temperature compensatedcrystal oscillator (temperature-compensated crystal oscillator)) It has 112, the divider 113, and the local filter 114.
[0060] Moreover, as a transceiver side (Tx side) which transmits, the above-mentioned communication device 100 is equipped with the TxIF filter 121, a mixer 122, Tx interstage filter 123, amplifier 124, a coupler 125, an isolator 126, and APC (automaticpower control)127 (APC) while it shares the above-mentioned antenna 101, and the above-mentioned above-mentioned antenna common section / RFTop filter 102.
[0061] And surface acoustic wave equipment equipped with the vertical joint mold filter of the gestalt 1 of operation or this which was mentioned above can be suitably used for Rx interstage filter 104, the 1stIF filter 106, the above-mentioned TxIF filter 121, or above-mentioned Tx interstage filter 123.
[0062] Thus, the surface acoustic wave filter (vertical joint mold filter) of the gestalt 1 of said operation or surface acoustic wave equipment equipped with this is used for the above-mentioned communication device in the gestalt of this operation. Since the above-mentioned surface acoustic wave filter is equipped with the very good transmission characteristic, the communication device of the above-mentioned configuration can be attaining the miniaturization with the good transceiver function more than the miniaturization, especially the GHz band.

[0063] Moreover, the example which uses the above-mentioned vertical joint mold filter or surface acoustic wave equipment equipped with this for the filter for RF of RKE (Remote Keyless Entry System) as other examples of the gestalt of this operation can be given.
[0064] That is, as shown in drawing 9 , although RKE200 in the gestalt of this operation is equipped with an antenna 201, the RxTop filter 202, amplifier 203, the mixer 204, the 1stIF filter 205, and the 1st local filter 206 grade, it can use suitably for the above-mentioned RxTop filter 202 especially surface acoustic wave equipment equipped with the vertical joint mold filter of the gestalt 1 of operation or this which was mentioned above.
[0065]
[Effect of the Invention] As mentioned above, it sets in the surface acoustic wave filter of a vertical joint resonator mold, and the surface acoustic wave filter concerning this invention is the revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. While using a substrate, when spacing of the head of the above-mentioned electrode finger which one electrode terminal has, and the electrode terminal of another side which counters this is set to gap length G and wavelength of the above-mentioned surface acoustic wave is set to lambda, it is the configuration that the relation of 0.3 lambda>=G is materialized.
[0066] If the wavelength lambda of a surface acoustic wave is shorter than 0.3 times and the above-mentioned gap length G is carried out, since the non-exciting field equivalent to the free surface can be made small according to the above-mentioned configuration, it becomes possible to suppress generating of SSBW. Therefore, aggravation of the surface smoothness in a passband can be avoided and generating of a superfluous narrow-band-ized phenomenon can be prevented effectively. Consequently, the effectiveness that the surface acoustic wave filter which has a high filter shape can be obtained is done so.
[0067] The surface acoustic wave filter concerning this invention is the configuration of having two or more dummy electrode fingers formed so that the above-mentioned electrode finger extended from the other party's electrode terminal may be countered, when the above-mentioned electrode terminal projects toward the above-mentioned opposite direction further in addition to the above-mentioned configuration.
[0068] According to the above-mentioned configuration, it becomes possible by forming a dummy electrode finger to suppress generating of Above SSBW further so that the above-mentioned electrode finger may be countered. Therefore, aggravation of the above-mentioned surface smoothness can be avoided and generating of a superfluous narrow-band-ized phenomenon can be prevented effectively. Consequently, the effectiveness that the surface acoustic wave filter which has a still higher filter shape can be obtained is done so.
[0069] The surface acoustic wave equipment concerning this invention is a configuration equipped with the surface acoustic wave filter of the above-mentioned configuration.
[0070] Moreover, the communication device concerning this invention is the configuration of using the surface acoustic wave filter of the above-mentioned configuration, or the surface acoustic wave equipment of the above-mentioned configuration.
[0071] According to each above-mentioned configuration, since it has the surface acoustic wave filter of high quality, the effectiveness that the function as surface acoustic wave equipment or a communication device can be raised further is done so.

[Translation done.]

* NOTICES *

TECHNICAL FIELD

[Field of the Invention] This invention relates to a communication device at a surface acoustic wave filter and surface acoustic wave equipment equipped with this, and a list, and is the revolution Y cut X propagation LiTaO3 as a piezo-electric substrate especially. It is related with a surface acoustic wave filter, and the surface acoustic wave equipment and the communication device using this of the vertical joint resonator mold using a substrate.

[Translation done.]

* NOTICES *

PRIOR ART

[Description of the Prior Art] A surface acoustic wave filter is a filter containing the surface acoustic element using the surface acoustic wave spread along a piezo-electric substrate front face, for example, is used for various applications prepared in a RF circuit, such as a surface acoustic wave filter, in mobile communications commercial scenes, such as a cellular phone.
[0003] Especially, since wavelength is short compared with an electromagnetic wave, the above-mentioned surface acoustic wave has the advantage of being easy to miniaturize surface acoustic wave equipment equipped with a surface acoustic wave filter itself. Therefore, in the field of communication devices, such as the above-mentioned cellular phone with which recent years more much more miniaturization and low back-ization are called for, the need of the above-mentioned surface acoustic wave filter or surface acoustic wave equipment is also very large.
[0004] Here, also in the above-mentioned surface acoustic wave filter, since especially the surface acoustic wave filter (it abbreviates to a vertical joint mold filter hereafter) of a vertical joint resonator mold can respond to low loss and a RF, its surface acoustic wave filter is in use.
[0005] As a concrete technique about such a vertical joint mold filter, the vertical joint dual mode surface acoustic wave filter currently indicated by JP,5-267990,A, for example is mentioned.
[0006] The vertical joint mold filter of the above-mentioned technique carries out contiguity arrangement of the three INTADIJITARU transducer electrodes (IDT electrode) along the propagation direction of a surface acoustic wave on a piezo-electric substrate, and has the configuration which arranges a reflector on the both sides further. And each IDT electrode limits spacing of the center to center of the electrode finger of the innermost part which counters mutually on the basis of the wavelength lambda of a surface acoustic wave. Consequently, it is possible to be able to realize the fractional bandwidth which reaches to 4%, even if it is a RF field near 1GHz, and to also make loss low.
[0007] By the way, although there are various things according to the application of this filter as a property required of a vertical joint mold filter including the technique of the above-mentioned official report, the filter for RKE(Remote Keyless Entry System) RF requires the property (narrow-band property) used as a narrow band especially, for example so that it can respond to necessary pass band width. In the former, in order to realize the above-mentioned narrow-band property to the vertical joint mold filter of this application, the Xtal substrate which has a zero temperature coefficient has been used as a piezo-electric substrate.
[0008] However, since the above-mentioned Xtal substrate has a low dielectric constant, an electromechanical coupling coefficient is also small and the impedance of the filter itself becomes high, a matching circuit is needed separately to a vertical joint mold filter. So, with the above-mentioned configuration, the inconvenient point in respect of [, such as complication of a configuration or an increment in components mark,] manufacture had arisen. And since loss became large, with the above-mentioned configuration, inconvenience had produced the vertical joint mold filter obtained also in respect of quality.
[0009] Then, in order to realize the above-mentioned narrow-band property recently, it is the revolution Y cut X propagation $LiTaO_3$ especially as a piezo-electric substrate. The substrate is used more often. This revolution Y cut X propagation $LiTaO_3$ As compared with what used the Xtal substrate, low impedance-ization of the vertical joint mold filter using a substrate is attained, and it is possible to control the above-mentioned inconvenience.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, it sets in the surface acoustic wave filter of a vertical joint resonator mold, and the surface acoustic wave filter concerning this invention is the revolution Y cut X propagation $LiTaO3$ as a piezo-electric substrate. While using a substrate, when spacing of the head of the above-mentioned electrode finger which one electrode terminal has, and the electrode terminal of another side which counters this is set to gap length G and wavelength of the above-mentioned surface acoustic wave is set to lambda, it is the configuration that the relation of 0.3 lambda>=G is materialized.
[0066] If the wavelength lambda of a surface acoustic wave is shorter than 0.3 times and the above-mentioned gap length G is carried out, since the non-exciting field equivalent to the free surface can be made small according to the above-mentioned configuration, it becomes possible to suppress generating of SSBW. Therefore, aggravation of the surface smoothness in a passband can be avoided and generating of a superfluous narrow-band-ized phenomenon can be prevented effectively. Consequently, the effectiveness that the surface acoustic wave filter which has a high filter shape can be obtained is done so.
[0067] The surface acoustic wave filter concerning this invention is the configuration of having two or more dummy electrode fingers formed so that the above-mentioned electrode finger extended from the other party's electrode terminal may be countered, when the above-mentioned electrode terminal projects toward the above-mentioned opposite direction further in addition to the above-mentioned configuration.
[0068] According to the above-mentioned configuration, it becomes possible by forming a dummy electrode finger to suppress generating of Above SSBW further so that the above-mentioned electrode finger may be countered. Therefore, aggravation of the above-mentioned surface smoothness can be avoided and generating of a superfluous narrow-band-ized phenomenon can be prevented effectively. Consequently, the effectiveness that the surface acoustic wave filter which has a still higher filter shape can be obtained is done so.
[0069] The surface acoustic wave equipment concerning this invention is a configuration equipped with the surface acoustic wave filter of the above-mentioned configuration.
[0070] Moreover, the communication device concerning this invention is the configuration of using the surface acoustic wave filter of the above-mentioned configuration, or the surface acoustic wave equipment of the above-mentioned configuration.
[0071] According to each above-mentioned configuration, since it has the surface acoustic wave filter of high quality, the effectiveness that the function as surface acoustic wave equipment or a communication device can be raised further is done so.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, it is the above-mentioned revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. If the vertical joint mold filter using a substrate tends to realize the above-mentioned narrow-band property, the trouble that surface smoothness worsens shortly will be produced.
[0011] As shown in drawing 10 , with the conventional vertical joint mold filter, the wave of a passband tapers off and, specifically, it has become a configuration (drawing Nakaya mark). Therefore, the ripple deflection used as the index of the surface smoothness in a passband gets worse, and the trouble that the width of face of a passband becomes narrow beyond the need is produced. In addition, the phenomenon in which the width of face of a passband becomes narrow beyond the need is made into a superfluous narrow-band-ized phenomenon.
[0012] This invention is made in view of the above-mentioned trouble, and the object is in offering a surface acoustic wave filter, and the surface acoustic wave equipment and the communication device using this of the quality vertical joint resonator mold which has the good filter shape which raised the surface smoothness in a passband further.

[Translation done.]

* NOTICES *

Japan Patent Office is not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

MEANS

[Means for Solving the Problem] this invention persons set in the surface acoustic wave filter of a vertical joint resonator mold, as a result of inquiring wholeheartedly, in order to cancel the above-mentioned trouble. As a piezo-electric substrate, it is the revolution Y cut X propagation LiTaO3. While using a substrate If spacing of the electrode finger which constitutes an IDT electrode, and the bus bar (electrode terminal) which counters this electrode finger is specified in the predetermined range based on the wavelength lambda of a surface acoustic wave The surface smoothness in a passband improves and it came to complete a header and this invention for a good filter shape being realized uniquely.
[0014] Namely, the surface acoustic wave filter concerning this invention In order to solve the above-mentioned technical problem, it has two or more electrode fingers extended toward the opposite direction from the electrode terminal and each electrode terminal of the couple which counters mutually. The INTADIJITARU transducer (IDT) electrode which forms the configuration where made these two or more electrode fingers cross, respectively, and each other were engaged In the surface acoustic wave filter of the vertical joint resonator mold which carries out contiguity arrangement along the propagation direction of a surface acoustic wave, and equips the both sides with two or more surface acoustic wave resonators which come to arrange the reflective structure further on a piezo-electric substrate It is the revolution Y cut X propagation LiTaO3 as the above-mentioned piezo-electric substrate. While using a substrate When spacing of the head of the above-mentioned electrode finger which one electrode terminal has, and the electrode terminal of another side which counters this is set to gap length G and wavelength of the above-mentioned surface acoustic wave is set to lambda, it is characterized by materializing the relation of 0.3 lambda>=G.
[0015] As a result of this invention persons' inquiring uniquely, it was considered to be the cause that the level of resonance mode decreased aggravation of the above-mentioned surface smoothness and generating of the superfluous narrow-band-ized phenomenon accompanying this under the effect of SSBW (Surface Skimming Bulk Wave) generated in the gap field between the head of the above-mentioned electrode finger and an electrode terminal (bus bar). It is known that this SSBW will be strongly emitted in the free surface. Therefore, if the non-exciting field which is equivalent to the free surface in an IDT electrode is made small, it will become possible to suppress generating of SSBW.
[0016] Then, according to the above-mentioned configuration, the wavelength lambda of a surface acoustic wave is shorter than 0.3 times, and gap length G which is spacing of the head of the above-mentioned electrode finger and an electrode terminal is carried out. Therefore, since the non-exciting field (gap field) equivalent to the above-mentioned free surface can be made small, it becomes possible to suppress generating of Above SSBW. Therefore, aggravation of the above-mentioned surface smoothness can be avoided and generating of a superfluous narrow-band-ized phenomenon can be prevented effectively. Consequently, the surface acoustic wave filter which has a high filter shape can be obtained.
[0017] In addition to the above-mentioned configuration, the surface acoustic wave filter concerning this invention is characterized by having two or more dummy electrode fingers formed so that the above-mentioned electrode finger extended from the other party's electrode terminal when the above-mentioned electrode terminal projects toward the above-mentioned opposite direction further may be countered.
[0018] According to the above-mentioned configuration, it becomes possible by forming a dummy electrode finger to suppress generating of Above SSBW further so that the above-mentioned electrode finger may be countered. Therefore, aggravation of the above-mentioned surface smoothness can be avoided and generating of a superfluous

narrow-band-ized phenomenon can be prevented effectively. Consequently, the surface acoustic wave filter which has a still higher filter shape can be obtained.
[0019] The surface acoustic wave equipment concerning this invention is characterized by having the surface acoustic wave filter of the above-mentioned configuration.
[0020] Moreover, the communication device concerning this invention is characterized by using the surface acoustic wave filter of the above-mentioned configuration, or the surface acoustic wave equipment of the above-mentioned configuration.
[0021] According to each above-mentioned configuration, since it has the surface acoustic wave filter of high quality, the function as surface acoustic wave equipment or a communication device can be raised further.
[0022]
[Embodiment of the Invention] [Gestalt 1 of operation] It will be as follows if the gestalt of operation of the 1st of this invention is explained based on drawing 1 thru/or drawing 7 . In addition, this invention is not limited to this.
[0023] The surface acoustic wave filter concerning this invention is the revolution Y cut X propagation $LiTaO_3$ as a piezo-electric substrate. On a substrate Have the resonator which has two or more INTADIJITARU transducer (IDT) electrodes and the reflective structure arranged so that this may be pinched. When wavelength of a surface acoustic wave is set to lambda, gap length G between the head of two or more electrode fingers which are the surface acoustic wave filters (vertical joint mold filter) of a vertical joint resonator mold, and the above-mentioned IDT electrode has, and the electrode terminal (bus bar) which counters it It sets up so that the relation of 0.3 lambda>=G may be materialized.
[0024] Moreover, the surface acoustic wave equipment concerning this invention is equipped with the surface acoustic wave filter of the above-mentioned configuration.
[0025] Specifically, for the vertical joint mold filter [in / as shown in drawing 2 / the gestalt of this operation] 1, the surface acoustic wave resonator 5 (it only considers as a resonator hereafter) which becomes two or more IDT electrode 3 -- from the reflector (reflector) 4-4 of a couple is $LiTaO_3$. It has composition formed on [two] the substrate 2. In addition, a reflective end face may be used instead of a reflector. Namely, the reflective structure of a wide sense should just be used.
[0026] Contiguity arrangement of three IDT electrode 3a, 3b, and the 3c is carried out, and the above-mentioned resonator 5 has the composition that the reflector 4-4 of a couple is arranged to these ends. The direction where three IDT electrode 3a, 3b, and 3c are arranged is a direction which met in the propagation direction of the surface acoustic wave in the above-mentioned vertical joint mold filter 1. Moreover, since it is arranged so that above-mentioned IDT electrode 3a, 3b, and 3c may be pinched, the reflector 4-4 will be arranged along the propagation direction of a surface acoustic wave like the orientation of IDT electrode 3a, 3b, and 3c.
[0027] With the gestalt of this operation, among three above-mentioned IDT electrode 3a, 3b, and 3c, the end of IDT electrode 3a and 3c is grounded, and the signal terminal 7 is formed in IDT electrode 3b.
[0028] In the above-mentioned vertical joint mold filter 1, the direction where the resonator 5-5 is arranged is a direction (lengthwise direction) which intersects perpendicularly in the propagation direction of the above-mentioned surface acoustic wave. And cascade connection of between resonators 5-5 is done by the connection 6 between each IDT electrode 3a, 3b, and 3c. Therefore, the vertical joint mold filter 1 of the above-mentioned configuration has the so-called two-step composition. In addition, the joint capacity formed with the ctenidium-like electrode so that the above-mentioned connection 6 could take adjustment of interstage may have composition connected so that it may become parallel electrically with the above-mentioned IDT electrode 3, and it is not limited especially.
[0029] In addition, as a configuration of the above-mentioned vertical joint mold filter 1, it is not limited to the above-mentioned two-step configuration. For example, you may be what formed one resonator 5 and made the connection number of stages one step, i.e., the thing of a single stage configuration, and may be what prepared three or more resonator 5 --, i.e., the thing of three or more steps of multistage configurations. Moreover, between each resonator 5-5, the connection method of interstage is not limited to the above-mentioned approach, either, and may be changed into other connection methods.
[0030] In drawing 2 , although each IDT electrode 3a, 3b, and 3c are illustrated typically, it has the composition of having two or more electrode finger (excitation electrode finger) 32 -- extended toward the bus bar (electrode terminal) 31-31 and each bus bar 31 of the couple which counters mutually as it is shown in drawing 1 , when a configuration is illustrated more concretely to the opposite direction of these IDT(s) electrode 3 --. Two or more above-mentioned

electrode finger 32 -- crosses, respectively, and has become the configuration which was engaged mutually.
[0031] The logarithm of one pair, then the electrode finger 32-32 which constitutes the IDT electrode 3 is suitably set up according to the demand characteristics of the vertical joint mold filter 1 in the combination of the electrode finger 32-32 per piece extended, respectively from each bus bar 31-31 which counters. Similarly, the width of face (decussation width of face) which each electrode finger 32 extended, respectively intersects is suitably set up according to demand characteristics from the bus bar 31-31 which counters.
[0032] Furthermore, by this invention, as shown in drawing 1 , when spacing of the head of the above-mentioned electrode finger 32 and the bus bar 31 which counters this is set to gap length G and this gap length G sets wavelength of a surface acoustic wave to lambda, it is specified that the relation of 0.3 lambda>=G is materialized.
[0033] It is the above-mentioned revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. With the vertical joint mold filter using a substrate, if it is going to realize a narrow-band property, the superfluous narrow-band-ized phenomenon which surface smoothness worsened, therefore was mentioned above will arise. This superfluous narrow-band-ized phenomenon is a gap field between the head of the above-mentioned electrode finger, and a bus bar, and is considered for SSBW (Surface Skimming Bulk Wave) to occur. That is, SSBW is the effect generated in the above-mentioned gap field, and it is for the level of resonance mode to decline.
[0034] It is known that Above SSBW will be strongly emitted in the free surface. Then, in an IDT electrode, it is making small the non-exciting field equivalent to the above-mentioned free surface, and it becomes possible to suppress generating of Above SSBW.
[0035] Here, as shown in drawing 1 , the gap field 30 between the head of the electrode finger 32 in the IDT electrode 3 and the bus bar 31 which counters it is excitation with the free surface which has not contributed. So, if the above-mentioned gap length G is shortened, since the gap field 30 will become narrow, a non-exciting field can be made small. Consequently, the surface smoothness in a passband can be improved and it becomes possible to prevent a superfluous narrow-band-ized phenomenon.
[0036] When the correlation with the above-mentioned gap length G, the deflection in a band (ripple deflection), and the width of face (bandwidth) of a passband was acquired, wavelength of a surface acoustic wave was set to lambda and the above-mentioned gap length G was actually specified below to 0.3lambda so that clearly from the example mentioned later, it was found out that the deflection in a band and bandwidth are improved. The above-mentioned ripple deflection is the index of surface smoothness, and it becomes good [surface smoothness], so that this value is small. In this invention, when it prescribed that gap length G became 0.3 lambda>=G, it turned out that ripple deflection is improved and bandwidth also becomes large.
[0037] In addition, although, as for gap length G, only 0.3lambda is specified as an upper limit and the minimum is not specified, the above-mentioned gap length G is that which points out spacing of the head of the electrode finger 32, and a bus bar 31, and always exceeds 0 until it gets tired (G> 0), and this is because it is not necessary to limit a minimum.
[0038] That is, in this invention, the lower limit of gap length G will be equivalent to the threshold value on the process at the time of forming the above-mentioned IDT electrode 3 to the upper limit of gap length G being 0.3lambda. For example, as an approach of forming the IDT electrode 3, although the wet etching method can generally be used, it is also possible to use the dry etching method. At this time, the threshold value of gap length G obtained by the dry etching method becomes smaller than the threshold value of gap length G obtained by the wet etching method. Therefore, the minimum of gap length G serves as threshold value of the process which forms the IDT electrode 3.
[0039] In this invention, further, as shown in drawing 3 , the IDT electrode 3 has projected toward the above-mentioned opposite direction, and may have two or more dummy electrode finger 33 -- formed so that the above-mentioned electrode finger 32 extended from the other party's bus bar 31 may be countered. That is, the dummy electrode 33 will be formed so that it may project from a bus bar 31 to the gap field 30 which is a non-exciting field.
[0040] Thus, if the dummy electrode finger 33 which counters the above-mentioned electrode finger 32 is formed, it is possible to be able to avoid aggravation of the above-mentioned surface smoothness much more certainly, and to prevent generating of a superfluous narrow-band-ized phenomenon more effectively so that clearly from the example mentioned later.
[0041] In addition, gap length G in case there is a dummy electrode finger 33 shall point out spacing from the head of the electrode finger 32 to the head of the dummy electrode finger 33 which counters it, as shown in drawing 3 . So, the die length of the dummy electrode finger 33 is a design matter chosen suitably, and is not especially limited by the size of above-mentioned gap length G and the IDT electrode 3 etc.

[0042] At this invention, it is the above-mentioned revolution Y cut X propagation LiTaO3 as a piezo-electric substrate. A substrate 2 is used. This revolution Y cut X propagation LiTaO3 As a substrate 2, it is not especially specifically limited. At the example mentioned later, it is the revolution Y cut X propagation LiTaO3. Although the thing of 36-degree revolution Y cut X propagation is used, even if cut angles other than this are used for the cut angle of a substrate 2, since the difference in physical properties does not participate in radiation of SSBW, it can acquire the same effectiveness.

[Translation done.]

* NOTICES *

EXAMPLE

[Example] A convention of the above-mentioned gap length G in the gestalt of this operation is more concretely explained based on the following examples. In addition, this example is an example for specifying the above-mentioned gap length G, and this invention is not limited to this example.
[0044] The vertical joint mold filter 1 (refer to drawing 2) of the two-step configuration mentioned above is mentioned as an example, and this example explains it. The fundamental configuration of the vertical joint mold filter 1 used by this example is as follows.
[0045] That is, center frequency used as the center of the passband in the vertical joint mold filter 1 was first set to 298MHz. Moreover, as a piezo-electric substrate, it is the 36-degree revolution Y cut X propagation LiTaO3. The substrate 2 was used. Electrode layer thickness was set to 400nm, using an aluminum-Cu alloy as an electrode material. As for each concrete configuration of the above-mentioned reflector 4, the number set wavelength to 13.82 micrometers by 41. Moreover, the logarithm of the electrode finger 32-32 in three IDT electrode 3a, 3b, and 3c shown in drawing 2 formed the concrete configuration of the above-mentioned IDT electrode 3 so that it might become 17 pairs, 22 pairs, and 17 pairs, respectively.
[0046] next, with the vertical joint mold filter (this invention mold filter) concerning this invention used by this example, when wavelength of a surface acoustic wave is set to lambda, it becomes below 0.3lambda about gap length G (0.3 lambda>=G) -- it has set up small like. Furthermore, in this example, the conventional vertical joint mold filter (conventional-type filter) which does not set up gap length G small is also used as usual for the comparison. Although the fundamental configuration is the same as this invention mold filter as this conventional-type filter, gap length G is set as 0.46lambda (G=0.46lambda).
[0047] The transmission characteristic was compared about each of the above-mentioned this invention mold filter and a conventional-type filter. The result is shown in drawing 4 and drawing 5 . In addition, with this invention mold filter which measured the transmission characteristic of drawing 4 and drawing 5 , the gap length G is set as 0.2lambda (G=0.2lambda). Moreover, the dotted line of this invention mold filter shows the transmission characteristic of a conventional-type filter, and a continuous line shows drawing 4 and drawing 5 by **-**, respectively. Furthermore, the axis of ordinate in drawing shows an insertion loss, and an axis of abscissa shows a frequency.
[0048] Drawing 4 measures the transmission characteristic of each above-mentioned filter simply. With this invention mold filter, it turns out that the tapering inclination of the transmission characteristic in a band is canceled, and surface smoothness can be improved as compared with a conventional-type filter, without changing any properties other than a passband so that clearly from drawing 4 .
[0049] On the other hand, in each above-mentioned filter, in order to clarify the location and level of resonance mode, drawing 5 measures the wave of a transmission characteristic, after removing adjustment with an external circuit intentionally. If the level of resonance mode is seen so that clearly from the result of drawing 5 , compared with a conventional-type filter, the peak level will rise with this invention mold filter. Therefore, it turns out that making it small has contributed gap length G on a flat disposition rather than the conventional configuration.
[0050] Next, the result evaluated quantitatively about the relation between the above-mentioned gap length G and the surface smoothness in a passband is shown below.
[0051] First, in the vertical joint mold filter of the above-mentioned basic configuration, when changing gap length G, it measured about change of the ripple deflection (deflection in a band) to gap length G it is changeless against the index of the above-mentioned surface smoothness. The result is shown in drawing 6 . In addition, in drawing 6 , it is a

vertical joint mold filter in case the dummy electrode finger 33 does not have a square black dot (configuration of drawing 1), and is a vertical joint mold filter in case the dummy electrode finger 33 has the black dot of a rhombus (configuration of drawing 3). Moreover, an axis of ordinate shows the deflection in a band (unit dB), and an axis of abscissa shows gap length G (lambda criteria). Furthermore, the die length of the dummy electrode finger 33 is about 2 lambda in this example.
[0052] If gap length G has become below 0.3lambda so that clearly from the result of drawing 6 , it turns out that the value of ripple deflection is sufficiently small. It is very clear by filling 0.3 lambda>=G with a vertical joint mold filter in case there is a dummy electrode especially that ripple deflection is fully falling.
[0053] Next, in the vertical joint mold filter of the above-mentioned basic configuration, when changing gap length G, it measured about change of the width of face (bandwidth) of the passband to gap length G. The result is shown in drawing 7 . In addition, drawing 7 is also a vertical joint mold filter in case the dummy electrode finger 33 does not have a square black dot (configuration of drawing 1), and it is a vertical joint mold filter in case the dummy electrode finger 33 has the black dot of a rhombus (configuration of drawing 3). Moreover, an axis of ordinate shows bandwidth (unit MHz), and an axis of abscissa shows gap length G (lambda criteria).
[0054] If gap length G has become below 0.3lambda so that clearly from the result of drawing 7 , sufficiently good bandwidth can be obtained. On the other hand, it turns out that bandwidth will decrease rapidly if gap length G exceeds 0.3lambda, and a superfluous narrow-band-ized phenomenon arises. If 0.3 lambda>=G is not filled, it becomes impossible therefore, to obtain sufficient filter shape as a vertical joint mold filter.
[0055] Furthermore, if the value of ripple deflection is large, surface smoothness will worsen and a superfluous narrow-band-ized phenomenon will arise, so that clearly from the comparison of drawing 6 and drawing 7 , but if the above-mentioned gap length G is set below to 0.3lambda, ripple deflection will be improved, the width of face of a passband will fully be secured, and it will become possible to prevent generating of a superfluous narrow-band-ized phenomenon.
[0056] Thus, at this invention, it is the revolution Y cut X propagation LiTaO3. On a substrate, two or more IDT electrodes have been arranged at the single tier, and gap length G between the heads of an electrode finger and bus bars (electrode terminal) in an IDT electrode is set below to 0.3lambda in the surface acoustic wave filter of the vertical joint resonator mold which has arranged the reflective structures, such as a reflector, so that this may be pinched further. Therefore, the surface smoothness in a passband can be raised and generating of a superfluous narrow-band-ized phenomenon can be prevented certainly.
[0057] [Gestalt 2 of operation] It will be as follows if the gestalt of operation of the 2nd of this invention is explained based on drawing 8 and drawing 9 . In addition, this invention is not limited to this. Moreover, the same number is appended to the member of explanation used with the gestalt 1 of said operation, and the member which has the same function for convenience, and the explanation is omitted.
[0058] The gestalt of this operation explains more concretely about the example applied to the communication device the vertical joint mold filter in the gestalt 1 of said operation, or surface acoustic wave equipment equipped with this.
[0059] As shown in drawing 8 , the communication device 100 in the gestalt of this operation Specifically as a receiver side (Rx side) which receives An antenna 101, the antenna common section / RFTop filter 102, amplifier 103, Rx interstage filter 104, a mixer 105, the 1stIF filter 106, a mixer 107, the 2ndIF filter 108, the 1st+2nd local synthesizer 111, TCXO (temperature compensatedcrystal oscillator (temperature-compensated crystal oscillator)) It has 112, the divider 113, and the local filter 114.
[0060] Moreover, as a transceiver side (Tx side) which transmits, the above-mentioned communication device 100 is equipped with the TxIF filter 121, a mixer 122, Tx interstage filter 123, amplifier 124, a coupler 125, an isolator 126, and APC (automaticpower control)127 (APC) while it shares the above-mentioned antenna 101, and the above-mentioned above-mentioned antenna common section / RFTop filter 102.
[0061] And surface acoustic wave equipment equipped with the vertical joint mold filter of the gestalt 1 of operation or this which was mentioned above can be suitably used for Rx interstage filter 104, the 1stIF filter 106, the above-mentioned TxIF filter 121, or above-mentioned Tx interstage filter 123.
[0062] Thus, the surface acoustic wave filter (vertical joint mold filter) of the gestalt 1 of said operation or surface acoustic wave equipment equipped with this is used for the above-mentioned communication device in the gestalt of this operation. Since the above-mentioned surface acoustic wave filter is equipped with the very good transmission characteristic, the communication device of the above-mentioned configuration can be attaining the miniaturization

with the good transceiver function more than the miniaturization, especially the GHz band.
[0063] Moreover, the example which uses the above-mentioned vertical joint mold filter or surface acoustic wave equipment equipped with this for the filter for RF of RKE (Remote Keyless Entry System) as other examples of the gestalt of this operation can be given.
[0064] That is, as shown in drawing 9 , although RKE200 in the gestalt of this operation is equipped with an antenna 201, the RxTop filter 202, amplifier 203, the mixer 204, the 1stIF filter 205, and the 1st local filter 206 grade, it can use suitably for the above-mentioned RxTop filter 202 especially surface acoustic wave equipment equipped with the vertical joint mold filter of the gestalt 1 of operation or this which was mentioned above.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the top view showing the outline configuration of the IDT electrode contained in the surface acoustic wave filter concerning this invention.
[Drawing 2] It is the top view showing an example containing the IDT electrode shown in drawing 1 of the outline configuration of the surface acoustic wave filter concerning this invention.
[Drawing 3] It is the outline top view showing other configurations of the IDT electrode shown in drawing 1 .
[Drawing 4] It is the graph which compares the transmission characteristic in the surface acoustic wave filter concerning this invention with the transmission characteristic in the conventional surface acoustic wave filter.
[Drawing 5] It is the graph which compares the transmission characteristic in the surface acoustic wave filter concerning this invention with the transmission characteristic in the conventional surface acoustic wave filter, and is the graph which shows the transmission characteristic acquired where adjustment is removed.
[Drawing 6] In the surface acoustic wave filter concerning this invention, it is the graph which shows the relation of the deflection in a band to gap length G.
[Drawing 7] In the surface acoustic wave filter concerning this invention, it is the graph which shows the relation of the width of face of the passband to gap length G.
[Drawing 8] It is the important section block diagram of the communication device concerning this invention.
[Drawing 9] It is the important section block diagram of RKE as other examples of the communication device concerning this invention.
[Drawing 10] It is the graph which shows the transmission characteristic of the vertical joint mold filter of the conventional configuration.
[Description of Notations]
1 Surface Acoustic Wave Filter of Vertical Joint Resonator Mold (Vertical Coupling Filter)
2 Revolution Y Cut X Propagation LiTaO3 Substrate
3 INTADIJITARU Transducer Electrode (IDT Electrode)
4 Reflector
31 Bus Bar (Electrode Terminal)
32 Electrode Finger
33 Dummy Electrode Finger
G Gap length
100 Communication Device
200 RKE (Communication Device)

[Translation done.]

(19)日本国特許庁(JP)　(12)公開特許公報（A）　(11)特許出願公開番号

特開２００２－３１４３６６
(Ｐ２００２－３１４３６６Ａ)
(43)公開日　平成14年10月25日(2002. 10. 25)

(51)Int. Cl.⁷	識別記号	F I		テーマコード(参考)
ＨＯ３Ｈ　9/145		ＨＯ３Ｈ　9/145	Z	5J097
9/64		9/64	Z	

審査請求　未請求　請求項の数４　ＯＬ　(全１０頁)

(21)出願番号　特願2001-110271(P2001-110271)

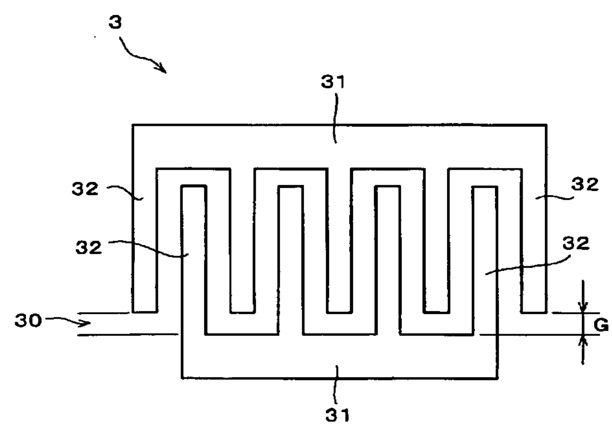
(22)出願日　平成13年4月9日(2001. 4. 9)

(71)出願人　000006231
株式会社村田製作所
京都府長岡京市天神二丁目26番10号
(72)発明者　能登　健一
京都府長岡京市天神二丁目26番10号　株式会社村田製作所内
(74)代理人　100080034
弁理士　原　謙三

Ｆターム(参考)　5J097 AA13 AA18 BB19 DD05 DD10
DD14 GG03 GG05 KK03

(54)【発明の名称】弾性表面波フィルタ、弾性表面波装置および通信装置

(57)【要約】
【課題】　通過帯域内の平坦度をより一層向上させた良好なフィルタ特性を有する、高品質な縦結合共振子型の弾性表面波フィルタを提供する。
【解決手段】　本発明では、上記圧電基板として回転ＹカットＸ伝搬$LiTaO_3$基板を用いるとともに、弾性表面波共振子を構成するＩＤＴ電極３におけるギャップ長Ｇを、弾性表面波の波長λの０．３倍以下に規定する（０．３λ≧Ｇ）。上記ギャップ長Ｇは、ＩＤＴ電極３を構成する一対のバスバー３１と、このバスバー３１から対向方向に向かって延長される複数の電極指３２…との間隔である。



【特許請求の範囲】

【請求項１】互いに対向する一対の電極端子と、各電極端子から対向方向に向かって延長される複数の電極指とを有し、該複数の電極指をそれぞれ交叉させて互いに噛み合わせた形状を形成するインターディジタルトランスデューサ電極を、圧電基板上に、複数個、弾性表面波の伝搬方向に沿って隣接配置し、さらにその両側に、反射構造体を配置してなる弾性表面波共振子を備える縦結合共振子型の弾性表面波フィルタにおいて、

上記圧電基板として回転ＹカットＸ伝搬ＬｉTaO_3基板を用いるとともに、

一方の電極端子が有する上記電極指の先端と、これに対向する他方の電極端子との間隔をギャップ長Ｇとし、上記弾性表面波の波長をλとした場合に、０．３λ≧Ｇの関係が成立することを特徴とする弾性表面波フィルタ。

【請求項２】上記電極端子は、さらに、上記対向方向に向かって突き出すことにより、相手方の電極端子から延長される上記電極指に対向するように形成される複数のダミー電極指を有することを特徴とする請求項１記載の弾性表面波フィルタ。

【請求項３】請求項１または２記載の弾性表面波フィルタを備えることを特徴とする弾性表面波装置。

【請求項４】請求項１または２記載の弾性表面波フィルタ、または請求項３記載の弾性表面波装置を用いることを特徴とする通信装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、弾性表面波フィルタ、およびこれを備える弾性表面波装置、並びに通信装置に関するものであり、特に、圧電基板として、回転ＹカットＸ伝搬ＬｉTaO_3基板を用いた縦結合共振子型の弾性表面波フィルタと、これを用いる弾性表面波装置および通信装置とに関するものである。

【０００２】

【従来の技術】弾性表面波フィルタは、圧電基板表面に沿って伝搬する弾性表面波を利用した弾性表面波素子を含むフィルタであり、たとえば携帯電話などの移動体通信市場においては、高周波回路に設けられる弾性表面波フィルタなど、様々な用途に用いられている。

【０００３】特に、上記弾性表面波は電磁波に比べて波長が短いため、弾性表面波フィルタを備える弾性表面波装置そのものを小型化し易いなどの利点がある。そのため、近年、より一層の小型化や低背化が求められている上記携帯電話などの通信装置の分野では、上記弾性表面波フィルタや弾性表面波装置の需要も非常に大きくなっている。

【０００４】ここで、上記弾性表面波フィルタの中でも、特に、縦結合共振子型の弾性表面波フィルタ（以下、縦結合型フィルタと略す）は、低損失かつ高周波に対応することができるため、弾性表面波フィルタの主流

となっている。

【０００５】このような縦結合型フィルタに関する具体的な技術としては、たとえば特開平５－２６７９９０号公報に開示されている縦結合二重モード弾性表面波フィルタが挙げられる。

【０００６】上記技術の縦結合型フィルタは、３個のインターディジタルトランスデューサ電極（ＩＤＴ電極）を、圧電基板上に、弾性表面波の伝搬方向に沿って隣接配置し、さらにその両側に反射器を配置する構成を有している。そして、各ＩＤＴ電極が互いに対向する最も内側の電極指の中心間の間隔を、弾性表面波の波長λを基準にして限定している。その結果、１ＧＨｚに近い高周波領域であっても４％に及ぶ比帯域を実現でき、かつ、損失も低くすることが可能となっている。

【０００７】ところで、上記公報の技術を含む、縦結合型フィルタに要求される特性としては、該フィルタの用途に応じて様々なものがあるが、中でも、たとえばＲＫＥ（Remote Keyless Entry System ）ＲＦ用フィルタでは、所要の通過帯域幅に対応し得るように、狭い帯域となる特性（狭帯域特性）が要求される。従来では、この用途の縦結合型フィルタに対しては、上記狭帯域特性を実現するために、圧電基板として、零温度係数を有する水晶基板が用いられてきた。

【０００８】しかしながら、上記水晶基板は誘電率が低く、電気機械結合係数も小さいことから、フィルタそのもののインピーダンスが高くなるため、縦結合型フィルタに対して、別途、整合回路が必要となる。それゆえ、上記構成では、構成の複雑化や部品点数の増加といった製造面での不都合な点が生じていた。しかも、得られる縦結合型フィルタは、損失が大きくなってしまうため、上記構成では、品質の面でも不都合が生じていた。

【０００９】そこで最近では、上記狭帯域特性を実現するために、圧電基板として、特に回転ＹカットＸ伝搬ＬｉTaO_3基板を用いることが多くなっている。この回転ＹカットＸ伝搬ＬｉTaO_3基板を用いた縦結合型フィルタは、水晶基板を用いたものと比較して、低インピーダンス化が可能となっており、上記不都合を抑制することが可能となっている。

【００１０】

【発明が解決しようとする課題】ところが、圧電基板として上記回転ＹカットＸ伝搬ＬｉTaO_3基板を用いた縦結合型フィルタで上記狭帯域特性を実現しようとすると、今度は、平坦性が悪くなるという問題点を生ずる。

【００１１】具体的には、図１０に示すように、従来の縦結合型フィルタでは、通過帯域の波形が先細り形状となっている（図中矢印）。そのため、通過帯域内における平坦性の指標となるリップル偏差が悪化し、通過帯域の幅が必要以上に狭くなるという問題点を生ずる。なお、通過帯域の幅が必要以上に狭くなる現象を、過剰狭帯域化現象とする。

【００１２】本発明は、上記問題点に鑑みてなされたものであって、その目的は、通過帯域内の平坦性をより一層向上させた良好なフィルタ特性を有する、高品質な縦結合共振子型の弾性表面波フィルタと、これを用いた弾性表面波装置および通信装置を提供することにある。

【００１３】

【課題を解決するための手段】本発明者らは、上記問題点を解消するために鋭意検討した結果、縦結合共振子型の弾性表面波フィルタにおいては、圧電基板として、回転ＹカットＸ伝搬$LiTaO_3$基板を用いるとともに、ＩＤＴ電極を構成する電極指と、この電極指に対向するバスバー（電極端子）との間隔を、弾性表面波の波長λに基づいて所定範囲に規定すると、通過帯域内における平坦性が向上し、良好なフィルタ特性が実現されることを独自に見出し、本発明を完成するに至った。

【００１４】すなわち、本発明にかかる弾性表面波フィルタは、上記の課題を解決するために、互いに対向する一対の電極端子と、各電極端子から対向方向に向かって延長される複数の電極指とを有し、該複数の電極指をそれぞれ交叉させて互いに噛み合わせた形状を形成するインターディジタルトランスデューサ（ＩＤＴ）電極を、圧電基板上に、複数個、弾性表面波の伝搬方向に沿って隣接配置し、さらにその両側に、反射構造体を配置してなる弾性表面波共振子を備える縦結合共振子型の弾性表面波フィルタにおいて、上記圧電基板として回転ＹカットＸ伝搬$LiTaO_3$基板を用いるとともに、一方の電極端子が有する上記電極指の先端と、これに対向する他方の電極端子との間隔をギャップ長Ｇとし、上記弾性表面波の波長をλとした場合に、０．３λ≧Ｇの関係が成立することを特徴としている。

【００１５】本発明者らが独自に検討した結果、上記平坦性の悪化と、これに伴う過剰狭帯域化現象の発生とは、上記電極指の先端と電極端子（バスバー）との間のギャップ領域で発生するＳＳＢＷ（Surface Skimming Bulk Wave）の影響により、共振モードのレベルが減衰することが原因ではないかと考えられた。このＳＳＢＷは、自由表面において強く放射されることが知られている。そのため、ＩＤＴ電極において自由表面に相当する非励振領域を小さくすれば、ＳＳＢＷの発生を抑えることが可能となる。

【００１６】そこで、上記構成によれば、上記電極指の先端と電極端子との間隔であるギャップ長Ｇを、弾性表面波の波長λの０．３倍よりも短くしている。そのため、上記自由表面に相当する非励振領域（ギャップ領域）を小さくすることができるので、上記ＳＳＢＷの発生を抑えることが可能となる。そのため、上記平坦性の悪化を回避し、過剰狭帯域化現象の発生を効果的に防止することができる。その結果、高いフィルタ特性を有する弾性表面波フィルタを得ることができる。

【００１７】本発明にかかる弾性表面波フィルタは、上記構成に加えて、上記電極端子が、さらに、上記対向方向に向かって突き出すことにより、相手方の電極端子から延長される上記電極指に対向するように形成される複数のダミー電極指を有することを特徴としている。

【００１８】上記構成によれば、上記電極指に対向するように、ダミー電極指を設けることによって、上記ＳＳＢＷの発生をより一層抑えることが可能となる。そのため、上記平坦性の悪化を回避し、過剰狭帯域化現象の発生を効果的に防止することができる。その結果、より一層高いフィルタ特性を有する弾性表面波フィルタを得ることができる。

【００１９】本発明にかかる弾性表面波装置は、上記構成の弾性表面波フィルタを備えることを特徴としている。

【００２０】また、本発明にかかる通信装置は、上記構成の弾性表面波フィルタ、または上記構成の弾性表面波装置を用いることを特徴としている。

【００２１】上記各構成によれば、高品質の弾性表面波フィルタを備えているため、弾性表面波装置または通信装置としての機能をより一層向上させることができる。

【００２２】

【発明の実施の形態】〔実施の形態１〕本発明の第１の実施の形態について図１ないし図７に基づいて説明すれば、以下の通りである。なお、本発明はこれに限定されるものではない。

【００２３】本発明にかかる弾性表面波フィルタは、圧電基板としての回転ＹカットＸ伝搬$LiTaO_3$基板上に、複数のインターディジタルトランスデューサ（ＩＤＴ）電極、およびこれを挟持するように配置される反射構造体を有する共振子を備える、縦結合共振子型の弾性表面波フィルタ（縦結合型フィルタ）であり、上記ＩＤＴ電極が有する複数の電極指の先端と、それに対向する電極端子（バスバー）との間のギャップ長Ｇを、弾性表面波の波長をλとしたときに、０．３λ≧Ｇの関係が成立するように設定するものである。

【００２４】また、本発明にかかる弾性表面波装置は、上記構成の弾性表面波フィルタを備えるものである。

【００２５】具体的には、たとえば、図２に示すように、本実施の形態における縦結合型フィルタ１は、複数のＩＤＴ電極３…と、一対のリフレクタ（反射器）４・４とからなる弾性表面波共振子５（以下、単に共振子とする）が、$LiTaO_3$基板２上に二つ形成された構成となっている。なお、リフレクタの代わりに、反射端面を用いても構わない。すなわち広義の反射構造体が用いられておればよい。

【００２６】上記共振子５は、３個のＩＤＴ電極３ａ・３ｂ・３ｃが隣接配置されており、この両端に一対のリフレクタ４・４が配置されている構成となっている。３個のＩＤＴ電極３ａ・３ｂ・３ｃが配置されている方向は、上記縦結合型フィルタ１における弾性表面波の伝搬

方向に沿った方向である。また、リフレクタ４・４は、上記ＩＤＴ電極３ａ・３ｂ・３ｃを挟持するように配置されているため、ＩＤＴ電極３ａ・３ｂ・３ｃの配置方向と同様、弾性表面波の伝搬方向に沿って配置されていることになる。

【００２７】本実施の形態では、上記３個のＩＤＴ電極３ａ・３ｂ・３ｃのうち、ＩＤＴ電極３ａ・３ｃの一端は接地されており、ＩＤＴ電極３ｂには信号端子７が設けられている。

【００２８】上記縦結合型フィルタ１において、共振子５・５が配置されている方向は、上記弾性表面波の伝搬方向に直交する方向（縦方向）である。そして、共振子５・５の間は、それぞれのＩＤＴ電極３ａ・３ｂ・３ｃの間で、接続部６により縦続接続されている。そのため、上記構成の縦結合型フィルタ１は、いわゆる２段構成となっている。なお、上記接続部６は、段間の整合がとれるように、櫛歯状電極で形成された結合容量が、上記ＩＤＴ電極３と電気的に並列となるように接続される構成となっていてもよく、特に限定されるものではない。

【００２９】なお、上記縦結合型フィルタ１の構成としては、上記２段構成に限定されるものではない。たとえば、共振子５を一つのみ設けて接続段数を１段としたもの、すなわち単段構成のものであってもよく、共振子５…を３個以上設けたもの、すなわち３段以上の多段構成のものであってもよい。また、各共振子５・５の間、すなわち段間の接続方法も、上記方法に限定されるものではなく、他の接続方法に変えてもよい。

【００３０】図２では、個々のＩＤＴ電極３ａ・３ｂ・３ｃを模式的に図示しているが、これらＩＤＴ電極３…の構成をより具体的に図示すると、図１に示すように、互いに対向する一対のバスバー（電極端子）３１・３１と、各バスバー３１から対向方向に向かって延長される複数の電極指（励振電極指）３２…とを有する構成となっている。上記複数の電極指３２…は、それぞれ交叉されて、互いに噛み合わせられたような形状となっている。

【００３１】対向する各バスバー３１・３１からそれぞれ延長された１個ずつの電極指３２・３２の組み合わせを１対とすれば、ＩＤＴ電極３を構成する電極指３２・３２の対数は、縦結合型フィルタ１の要求特性に応じて適宜設定される。同じく、対向するバスバー３１・３１からそれぞれ延長された各電極指３２が交叉する幅（交叉幅）も、要求特性に応じて適宜設定される。

【００３２】さらに、本発明では、図１に示すように、上記電極指３２の先端と、これに対向するバスバー３１との間隔をギャップ長Ｇとしており、このギャップ長Ｇが、弾性表面波の波長をλとした場合に、０．３λ≧Ｇの関係が成立するように規定されている。

【００３３】圧電基板として上記回転ＹカットＸ伝搬Ｌ

ｉＴａＯ₃基板を用いた縦結合型フィルタでは、狭帯域特性を実現しようとすると、平坦性が悪くなり、そのために前述した過剰狭帯域化現象が生じる。この過剰狭帯域化現象は、上記電極指の先端とバスバーの間のギャップ領域で、ＳＳＢＷ（Surface Skimming Bulk Wave）が発生するためと考えられる。すなわち、ＳＳＢＷが上記ギャップ領域で発生する影響で、共振モードのレベルが減衰するためである。

【００３４】上記ＳＳＢＷは自由表面において強く放射されることが知られている。そこで、ＩＤＴ電極においては、上記自由表面に相当する非励振領域を小さくすることで、上記ＳＳＢＷの発生を抑えることが可能となる。

【００３５】ここで、図１に示すように、ＩＤＴ電極３における電極指３２の先端と、それに対向するバスバー３１との間のギャップ領域３０は、励振には寄与していない自由表面となっている。それゆえ、上記ギャップ長Ｇを短くすれば、ギャップ領域３０が狭くなるため、非励振領域を小さくすることができる。その結果、通過帯域内における平坦性を改善することができ、過剰狭帯域化現象を防止することが可能となる。

【００３６】後述する実施例から明らかなように、実際に、上記ギャップ長Ｇと帯域内偏差（リップル偏差）および通過帯域の幅（帯域幅）との相関関係を得たところ、弾性表面波の波長をλとした場合、上記ギャップ長Ｇを０．３λ以下に規定すれば、帯域内偏差および帯域幅が改善されることが見出された。上記リップル偏差は平坦性の指標であり、この値が小さいほど平坦性が良好となる。本発明では、ギャップ長Ｇを０．３λ≧Ｇとなるように規定すると、リップル偏差が改善され、帯域幅も広くなることがわかった。

【００３７】なお、ギャップ長Ｇは上限として０．３λのみ規定されており、下限が規定されていないが、これは、上記ギャップ長Ｇが、飽くまで、電極指３２の先端とバスバー３１との間隔を指すものであり、常に０を超える（Ｇ＞０）ので、下限を限定する必要がないためである。

【００３８】すなわち、本発明では、ギャップ長Ｇの上限値は０．３λとなっているのに対し、ギャップ長Ｇの下限値は、上記ＩＤＴ電極３を形成する際のプロセス上の限界値に相当することになる。たとえば、ＩＤＴ電極３を形成する方法としては、一般的にウエットエッチング法を用いることができるが、ドライエッチング法を用いることも可能である。このとき、ドライエッチング法で得られるギャップ長Ｇの限界値は、ウエットエッチング法で得られるギャップ長Ｇの限界値よりも小さくなる。したがって、ギャップ長Ｇの下限は、ＩＤＴ電極３を形成するプロセスの限界値となる。

【００３９】本発明では、さらに、図３に示すように、ＩＤＴ電極３は、さらに、上記対向方向に向かって突き

出しており、相手方のバスバー３１から延長される上記電極指３２に対向するように形成される複数のダミー電極指３３…を有していてもよい。すなわち、ダミー電極３３は、バスバー３１から、非励振領域であるギャップ領域３０に対して突出するように形成されていることになる。

【００４０】このように、上記電極指３２に対向するダミー電極指３３を設けると、後述する実施例から明らかなように、上記平坦性の悪化をより一層確実に回避でき、過剰狭帯域化現象の発生をより効果的に防止することが可能となっている。

【００４１】なお、ダミー電極指３３が有る場合のギャップ長Ｇは、図３に示すように、電極指３２の先端から、それに対向するダミー電極指３３の先端までの間隔を指すものとする。それゆえ、ダミー電極指３３の長さは、上記ギャップ長ＧおよびＩＤＴ電極３のサイズなどによって適宜選択される設計事項であり、特に限定されるものではない。

【００４２】本発明では、圧電基板として上記回転Ｙカット Ｘ伝搬$LiTaO_3$基板２が用いられる。この回転Ｙカット Ｘ伝搬$LiTaO_3$基板２としては、具体的には、特に限定されるものではない。後述する実施例では、回転Ｙカット Ｘ伝搬$LiTaO_3$基板２のカット角は、３６°回転Ｙカット Ｘ伝搬のものが用いられているが、これ以外のカット角を用いても、物性上の差異はＳＳＢＷの放射には関与しないため、同様の効果を得ることができる。

【００４３】〔実施例〕本実施の形態における上記ギャップ長Ｇの規定について、以下の実施例に基づいてより具体的に説明する。なお、本実施例は、上記ギャップ長Ｇを規定するための一例であって、本発明はこの実施例に限定されるものではない。

【００４４】本実施例では、上述した２段構成の縦結合型フィルタ１（図２参照）を例に挙げて説明する。本実施例で用いた縦結合型フィルタ１の基本的な構成は、次のようになっている。

【００４５】すなわち、まず、縦結合型フィルタ１における通過帯域の中央となる中心周波数は、２９８ＭＨｚとした。また、圧電基板としては、３６°回転Ｙカット Ｘ伝搬$LiTaO_3$基板２を用いた。電極材料としてはＡｌ－Ｃｕ合金を用い、電極膜厚を４００ｎｍとした。上記リフレクタ４の具体的な構成は、何れも、本数が４１本で波長を１３．８２μｍとした。また、上記ＩＤＴ電極３の具体的な構成は、図２に示す３個のＩＤＴ電極３ａ・３ｂ・３ｃにおける電極指３２・３２の対数が、それぞれ１７対、２２対、１７対となるように形成した。

【００４６】次に、本実施例で用いられる、本発明にかかる縦結合型フィルタ（本発明型フィルタ）では、弾性表面波の波長をλとした場合に、ギャップ長Ｇを０．３λ以下となる（０．３λ≧Ｇ）ように小さく設定している。さらに、本実施例では、比較のために、従来と同様に、ギャップ長Ｇを小さく設定しない従来の縦結合型フィルタ（従来型フィルタ）も用いている。この従来型フィルタとしては、基本的な構成は本発明型フィルタと同じであるが、ギャップ長Ｇを０．４６λ（Ｇ＝０．４６λ）に設定している。

【００４７】上記本発明型フィルタと、従来型フィルタとのそれぞれについて、その伝送特性を比較した。その結果を図４および図５に示す。なお、図４および図５の伝送特性を計測した本発明型フィルタでは、そのギャップ長Ｇを０．２λに設定している（Ｇ＝０．２λ）。また、図４および図５においては、実線が本発明型フィルタの、点線が従来型フィルタの伝送特性を示し、それぞれ①・②で示す。さらに、図中縦軸が挿入損失を、横軸が周波数を示す。

【００４８】図４は、上記各フィルタの伝送特性を単純に計測したものである。図４から明らかなように、本発明型フィルタでは、従来型フィルタと比較して、通過帯域以外の特性を変えずに、帯域内の伝送特性の先細り傾向が解消されて、平坦性を改善することができることが分かる。

【００４９】一方、図５は、共振モードの位置とレベルとを明確にするために、上記各フィルタにおいて、故意に外部回路との整合を外した上で、伝送特性の波形を計測したものである。図５の結果から明らかなように、共振モードのレベルを見ると、従来型フィルタに比べて、本発明型フィルタでは、ピークレベルが上昇している。したがって、従来の構成よりもギャップ長Ｇを小さくすることが、平坦性向上に寄与していることがわかる。

【００５０】次に、上記ギャップ長Ｇと通過帯域内における平坦性との関係について定量的に評価した結果を以下に示す。

【００５１】まず、上記基本構成の縦結合型フィルタにおいて、ギャップ長Ｇを変化させた場合に、上記平坦性の指標となる、ギャップ長Ｇに対するリップル偏差（帯域内偏差）の変化について計測した。その結果を図６に示す。なお、図６では、正方形の黒ドットがダミー電極指３３が無い場合（図１の構成）の縦結合型フィルタであり、菱形の黒ドットがダミー電極指３３が有る場合（図３の構成）の縦結合型フィルタである。また、縦軸が帯域内偏差（単位ｄＢ）を示し、横軸がギャップ長Ｇ（λ基準）を示す。さらに、ダミー電極指３３の長さは、本実施例では、約２λとなっている。

【００５２】図６の結果から明らかなように、ギャップ長Ｇが０．３λ以下となっていれば、リップル偏差の値は十分小さくなっていることがわかる。特に、ダミー電極が有る場合の縦結合型フィルタでは、０．３λ≧Ｇを満たすことによって、リップル偏差が十分に低下していることが非常に明確となっている。

【００５３】次に、上記基本構成の縦結合型フィルタにおいて、ギャップ長Ｇを変化させた場合に、ギャップ長Ｇに対する通過帯域の幅（帯域幅）の変化について計測した。その結果を図７に示す。なお、図７でも、正方形の黒ドットがダミー電極指３３が無い場合（図１の構成）の縦結合型フィルタであり、菱形の黒ドットがダミー電極指３３が有る場合（図３の構成）の縦結合型フィルタである。また、縦軸が帯域幅（単位ＭＨｚ）を示し、横軸がギャップ長Ｇ（λ基準）を示す。

【００５４】図７の結果から明らかなように、ギャップ長Ｇが０．３λ以下となっていれば、十分良好な帯域幅を得ることができる。これに対して、ギャップ長Ｇが０．３λを超えると帯域幅が急激に減少してしまい、過剰狭帯域化現象が生じることがわかる。そのため、０．３λ≧Ｇを満たさなければ、縦結合型フィルタとしての十分なフィルタ特性を得ることができなくなる。

【００５５】さらに、図６および図７の比較から明らかなように、リップル偏差の値が大きいと、平坦性が悪くなり、過剰狭帯域化現象が生じるが、上記ギャップ長Ｇを０．３λ以下に設定すれば、リップル偏差が改善され、通過帯域の幅が十分に確保され、過剰狭帯域化現象の発生を防止することが可能になる。

【００５６】このように、本発明では、回転ＹカットＸ伝搬ＬｉＴａO_3基板上に、複数のＩＤＴ電極を一列に配置し、さらにこれを挟持するようにリフレクタなどの反射構造体を配置した縦結合共振子型の弾性表面波フィルタにおいて、ＩＤＴ電極における電極指の先端とバスバー（電極端子）との間のギャップ長Ｇを０．３λ以下に設定している。そのため、通過帯域内における平坦性を向上させ、過剰狭帯域化現象の発生を確実に防止することができる。

【００５７】〔実施の形態２〕本発明の第２の実施の形態について図８および図９に基づいて説明すれば、以下の通りである。なお、本発明はこれに限定されるものではない。また、説明の便宜上、前記実施の形態１で使用した部材と同じ機能を有する部材には同一の番号を付記し、その説明を省略する。

【００５８】本実施の形態では、前記実施の形態１における縦結合型フィルタ、または、これを備える弾性表面波装置を通信装置に応用した例についてより具体的に説明する。

【００５９】図８に示すように、本実施の形態における通信装置１００は、具体的には、受信を行うレシーバ側（Ｒｘ側）として、アンテナ１０１、アンテナ共用部／ＲＦＴｏｐフィルタ１０２、アンプ１０３、Ｒｘ段間フィルタ１０４、ミキサ１０５、１ｓｔＩＦフィルタ１０６、ミキサ１０７、２ｎｄＩＦフィルタ１０８、１ｓｔ＋２ｎｄローカルシンセサイザ１１１、ＴＣＸＯ（temperature compensatedcrystal oscillator（温度補償型水晶発振器））１１２、デバイダ１１３、ローカルフィルタ１１４を備えている。

【００６０】また、上記通信装置１００は、送信を行うトランシーバ側（Ｔｘ側）として、上記アンテナ１０１および上記アンテナ共用部／ＲＦＴｏｐフィルタ１０２を共用するとともに、ＴｘＩＦフィルタ１２１、ミキサ１２２、Ｔｘ段間フィルタ１２３、アンプ１２４、カプラ１２５、アイソレータ１２６、ＡＰＣ（automaticpower control （自動出力制御））１２７を備えている。

【００６１】そして、上記のＲｘ段間フィルタ１０４、１ｓｔＩＦフィルタ１０６、ＴｘＩＦフィルタ１２１、あるいはＴｘ段間フィルタ１２３には、上述した実施の形態１の縦結合型フィルタまたはこれを備える弾性表面波装置を好適に用いることができる。

【００６２】このように、本実施の形態における上記通信装置は、前記実施の形態１の弾性表面波フィルタ（縦結合型フィルタ）、またはこれを備える弾性表面波装置を用いている。上記弾性表面波フィルタは、非常に良好な伝送特性を備えているので、上記構成の通信装置は、良好な送受信機能と共に小型化、特にＧＨｚ帯域以上において小型化を図れるものとなっている。

【００６３】また、本実施の形態の他の例として、上記縦結合型フィルタ、または、これを備える弾性表面波装置を、ＲＫＥ（Remote Keyless Entry System ）のＲＦ用フィルタに用いる例を挙げることができる。

【００６４】すなわち、図９に示すように、本実施の形態におけるＲＫＥ２００は、アンテナ２０１、ＲｘＴｏｐフィルタ２０２、アンプ２０３、ミキサ２０４、１ｓｔＩＦフィルタ２０５、１ｓｔローカルフィルタ２０６等を備えているが、このうち、特に、上記ＲｘＴｏｐフィルタ２０２には、上述した実施の形態１の縦結合型フィルタまたはこれを備える弾性表面波装置を好適に用いることができる。

【００６５】

【発明の効果】以上のように、本発明にかかる弾性表面波フィルタは、縦結合共振子型の弾性表面波フィルタにおいて、圧電基板として回転ＹカットＸ伝搬ＬｉＴａO_3基板を用いるとともに、一方の電極端子が有する上記電極指の先端と、これに対向する他方の電極端子との間隔をギャップ長Ｇとし、上記弾性表面波の波長をλとした場合に、０．３λ≧Ｇの関係が成立する構成である。

【００６６】上記構成によれば、上記ギャップ長Ｇを、弾性表面波の波長λの０．３倍よりも短くすれば、自由表面に相当する非励振領域を小さくすることができるので、ＳＳＢＷの発生を抑えることが可能となる。そのため、通過帯域内における平坦性の悪化を回避し、過剰狭帯域化現象の発生を効果的に防止することができる。その結果、高いフィルタ特性を有する弾性表面波フィルタを得ることができるという効果を奏する。

【００６７】本発明にかかる弾性表面波フィルタは、上記構成に加えて、上記電極端子が、さらに、上記対向方

向に向かって突き出すことにより、相手方の電極端子から延長される上記電極指に対向するように形成される複数のダミー電極指を有する構成である。

【００６８】上記構成によれば、上記電極指に対向するように、ダミー電極指を設けることによって、上記ＳＳＢＷの発生をより一層抑えることが可能となる。そのため、上記平坦性の悪化を回避し、過剰狭帯域化現象の発生を効果的に防止することができる。その結果、より一層高いフィルタ特性を有する弾性表面波フィルタを得ることができるという効果を奏する。

【００６９】本発明にかかる弾性表面波装置は、上記構成の弾性表面波フィルタを備える構成である。

【００７０】また、本発明にかかる通信装置は、上記構成の弾性表面波フィルタ、または上記構成の弾性表面波装置を用いる構成である。

【００７１】上記各構成によれば、高品質の弾性表面波フィルタを備えているため、弾性表面波装置または通信装置としての機能をより一層向上させることができるという効果を奏する。

【図面の簡単な説明】

【図１】本発明にかかる弾性表面波フィルタに含まれるＩＤＴ電極の概略構成を示す平面図である。

【図２】図１に示すＩＤＴ電極を含む、本発明にかかる弾性表面波フィルタの概略構成の一例を示す平面図である。

【図３】図１に示すＩＤＴ電極の他の構成を示す概略平面図である。

【図４】本発明にかかる弾性表面波フィルタにおける伝送特性と、従来の弾性表面波フィルタにおける伝送特性とを比較するグラフである。

【図５】本発明にかかる弾性表面波フィルタにおける伝送特性と、従来の弾性表面波フィルタにおける伝送特性とを比較するグラフであり、整合を外した状態で得られた伝送特性を示すグラフである。

【図６】本発明にかかる弾性表面波フィルタにおいて、ギャップ長Ｇに対する帯域内偏差の関係を示すグラフである。

【図７】本発明にかかる弾性表面波フィルタにおいて、ギャップ長Ｇに対する通過帯域の幅の関係を示すグラフである。

【図８】本発明にかかる通信装置の要部ブロック図である。

【図９】本発明にかかる通信装置の他の例としての、ＲＫＥの要部ブロック図である。

【図１０】従来の構成の縦結合型フィルタの伝送特性を示すグラフである。

【符号の説明】

１　縦結合共振子型の弾性表面波フィルタ（縦結合フィルタ）

２　回転ＹカットＸ伝搬ＬｉＴａO_3基板

３　インターディジタルトランスデューサ電極（ＩＤＴ電極）

４　反射器

３１　バスバー（電極端子）

３２　電極指

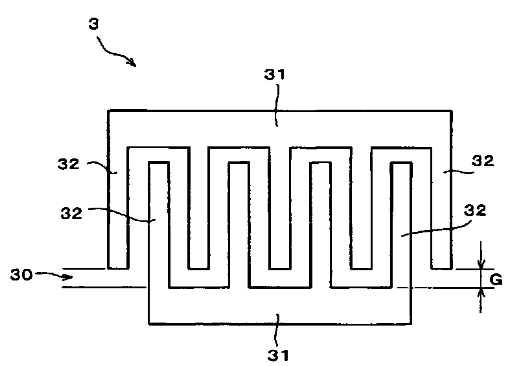
３３　ダミー電極指

Ｇ　ギャップ長

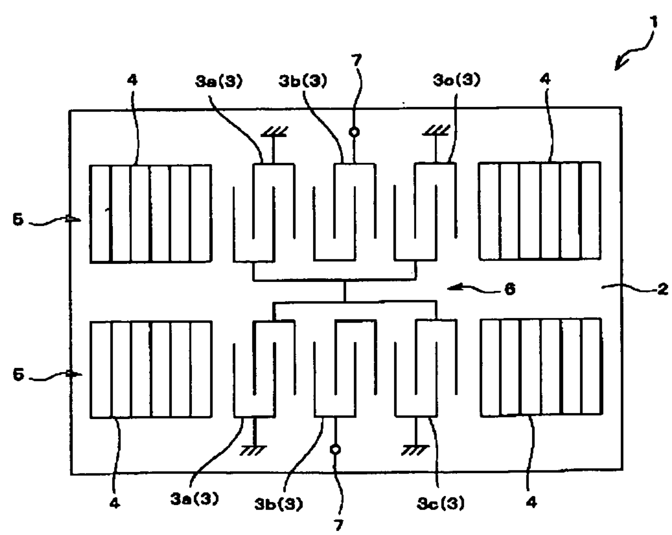
１００　通信装置

２００　ＲＫＥ（通信装置）

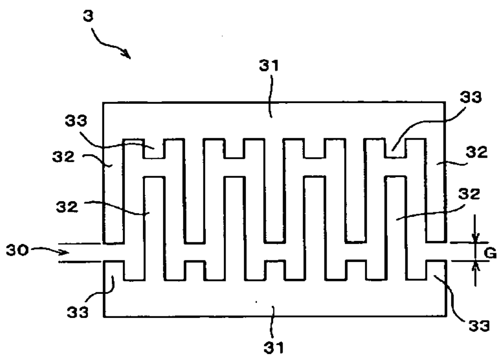
【図１】



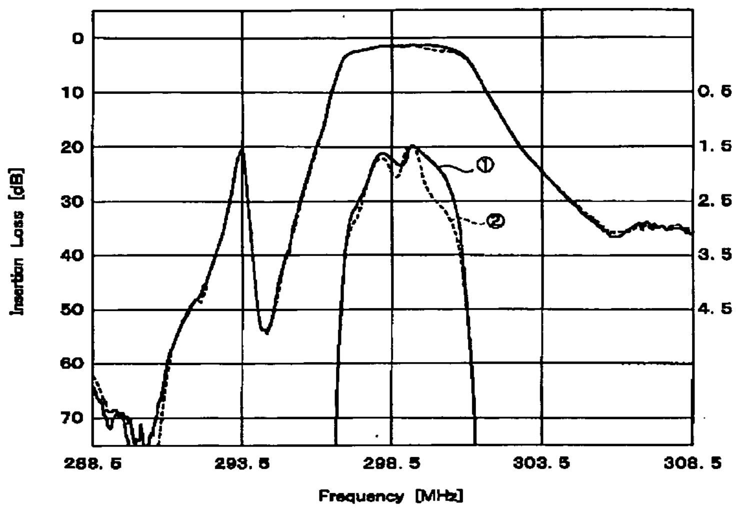
【図２】



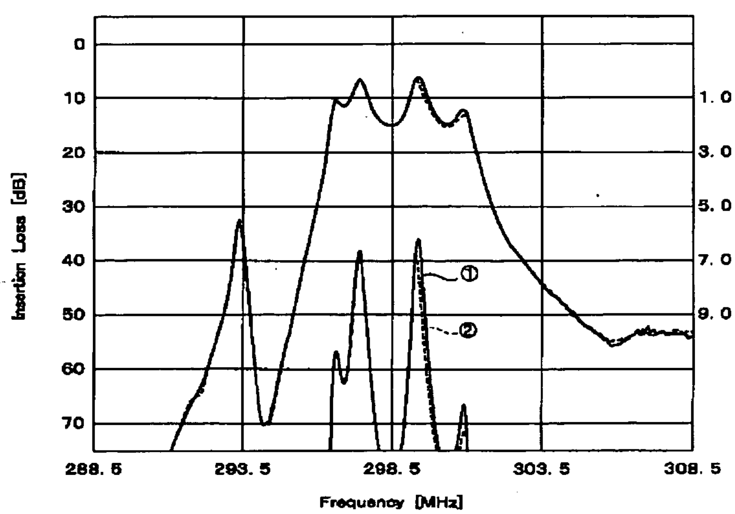
【図３】


3
31
33
33
32
32
32
32
30
G
33
33
31

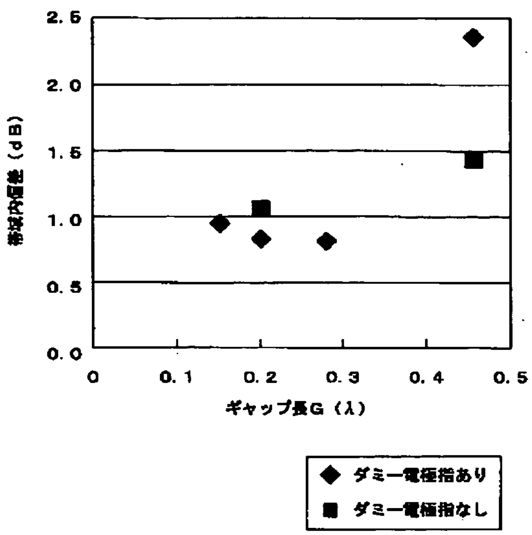
【図４】


0
10
20
30
40
50
60
70
0. 5
1. 5
2. 5
3. 5
4. 5
Insertion Loss [dB]
①
②
288. 5
293. 5
298. 5
303. 5
308. 5
Frequency [MHz]

【図５】

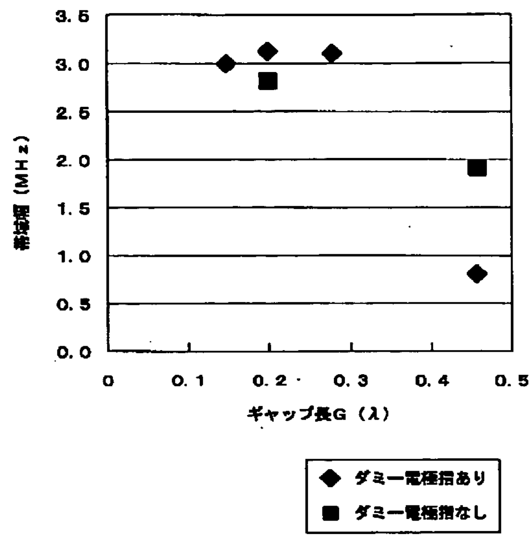

0
10
20
30
40
50
60
70
1. 0
3. 0
5. 0
7. 0
9. 0
Insertion Loss [dB]
①
②
288. 5
293. 5
298. 5
303. 5
308. 5
Frequency [MHz]

【図６】



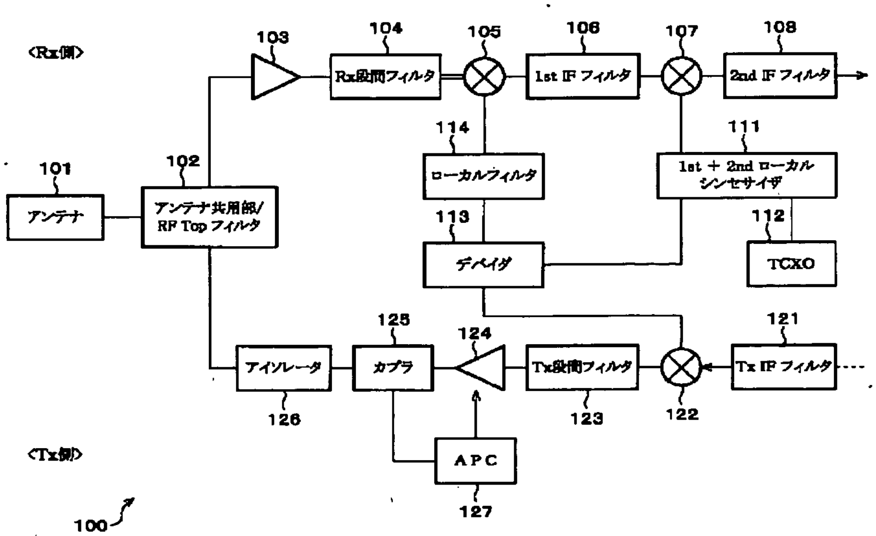
帯域内偏差（dB）
2.5
2.0
1.5
1.0
0.5
0.0
0
0.1
0.2
0.3
0.4
0.5
ギャップ長G（λ）
ダミー電極指あり
ダミー電極指なし

【図７】



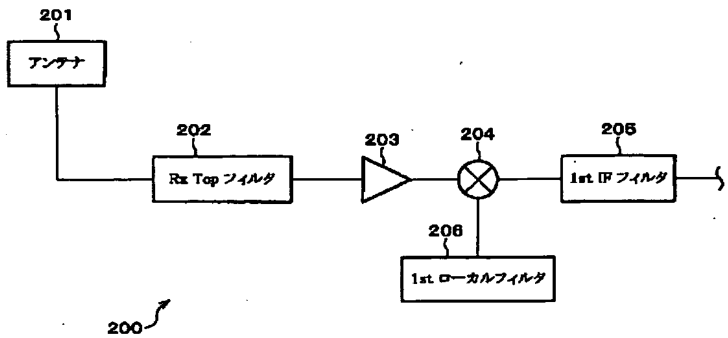
帯域幅（MHz）
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
0.1
0.2
0.3
0.4
0.5
ギャップ長G（λ）
ダミー電極指あり
ダミー電極指なし

【図８】

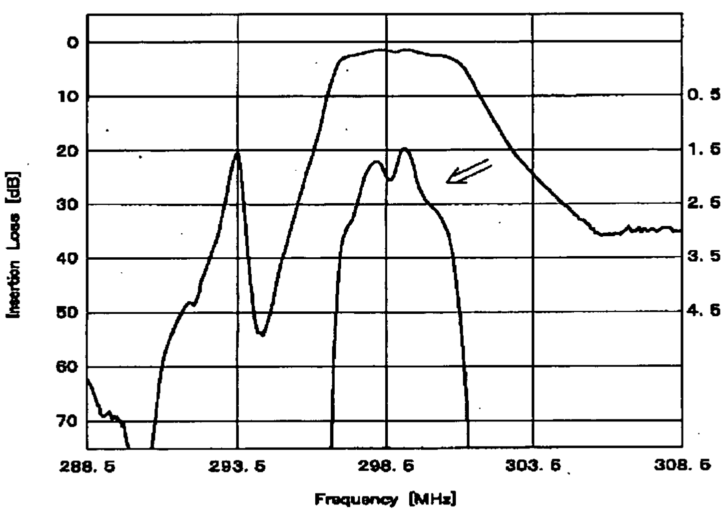


<Rx側>
<Tx側>
101
アンテナ
102
アンテナ共用部/
RF Top フィルタ
103
104
Rx段間フィルタ
105
106
1st IF フィルタ
107
108
2nd IF フィルタ
114
ローカルフィルタ
111
1st ＋ 2nd ローカル
シンセサイザ
113
デバイダ
112
TCXO
121
Tx IF フィルタ
122
123
Tx段間フィルタ
124
125
カプラ
126
アイソレータ
APC
127
100

【図９】


201
アンテナ
202
Rx Top フィルタ
203
204
205
1st IF フィルタ
206
1st ローカルフィルタ
200

【図１０】


Insertion Loss [dB]
0
10
20
30
40
50
60
70
0. 5
1. 5
2. 5
3. 5
4. 5
288. 5
293. 5
298. 5
303. 5
308. 5
Frequency [MHz]